VOL. IV, PART II. QUARTERLY. APRIL 1909

THE AGRICULTURAL JOURNAL OF INDIA

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA
BY
THACKER, SPINK & CO., CALCUTTA
W. THACKER & CO., 2, CREED LANE, LONDON

CALCUTTA:
PRINTED BY THACKER, SPINK AND CO.

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ERRATUM.

Vol. IV, Part I, page 17, fifth line from bottom, *for* "tracts" *read* "trade."

PLATE VI

JERI SILK WORMS

ERI OR CASTOR SILK.

By H. MAXWELL-LEFROY, M.A., F.Z.S., F.E.S.,

Imperial Entomologist, Pusa.

Eri silk is the cocoon of an insect known to science as *Attacus ricini* and probably the domesticated form of *Attacus cynthia* which is found in a wild state in Assam and along the outer forested slopes of the Himalayas. Eri silk is domesticated in the Assam valley, where it is grown for local use and, to a limited extent, for export. With Muga silk (*Antheræa assama*) it forms what is known in India as "Assam silk" as apart from Tusser and from mulberry silk.

At the present time, eri is not generally cultivated outside Eastern Bengal and Assam, Rungpur being about its western limit. During the past two years it has been experimentally grown at Pusa, and it is being grown also in other parts of India, from seed obtained from Pusa.

Eri silk has peculiarities which distinguish it from all other silks cultivated or collected in India. In the first place, the worms require only castor leaves for food; mulberry is not a food-plant. In the second, the cocoon is not a closed one and is not reelable in the same way as are mulberry or tusser silk cocoons; the caterpillar, in preparing the cocoon, leaves one end closed only with converging loops of silk, so that, while nothing can get in, the moth can push out; but the cocoon is made in layers, is not composed of a single thread and cannot be reeled by the ordinary process. On the other hand, the silk has this immense advantage, that the cocoons do not require to be "stifled," *i.e.*, killed, to prevent the egress of the moth; in preparing mulberry and tusser silk, the cocoon is killed, since the moth in getting out so damages

the cocoon that it cannot be reeled so well; in eri silk this is not so; the moth, as here utilised for spinning, must be allowed to emerge, and the taking of life, so abhorrent to many classes in India, is not necessary.

Another feature, shared with the "indigenous" mulberry silkworm, is the number of broods; seven or eight broods are obtained yearly, and as the production of eggs is large, a large brood can be secured from a small quantity of initial seed when castor is plentiful, and several crops of cocoons are obtainable yearly. The insect is completely domesticated in the sense that it will not run wild and become a pest; the whole life is passed in captivity, and the moths do not attempt to leave the rearing house. Rearing can be done in any building; the Pusa rearing has been done entirely in a grass and bamboo house (Plates VIII & IX). Lastly, the silk cocoons can be utilised just as cotton is, but yield a cloth far more durable and lasting; the cocoons are boiled, and then spun in the ordinary way that cotton is; the thread produced can be woven just as cotton thread is, and the cloth produced, while not so fine as machine-woven cotton cloth, is white, durable and much in demand. Dyed cloth is produced with ease by dyeing the cocoons, the thread or the cloth; and E. R. Watson has shown that silk is more easily dyed in fast colours with the ordinary indigenous dyes than is cotton, and that the dyeing of silk is easier than is the dyeing of cotton. With the indigenous and the synthetic (aniline) dyes, a great range of colours can be produced, and the dyeing offers no special difficulties.

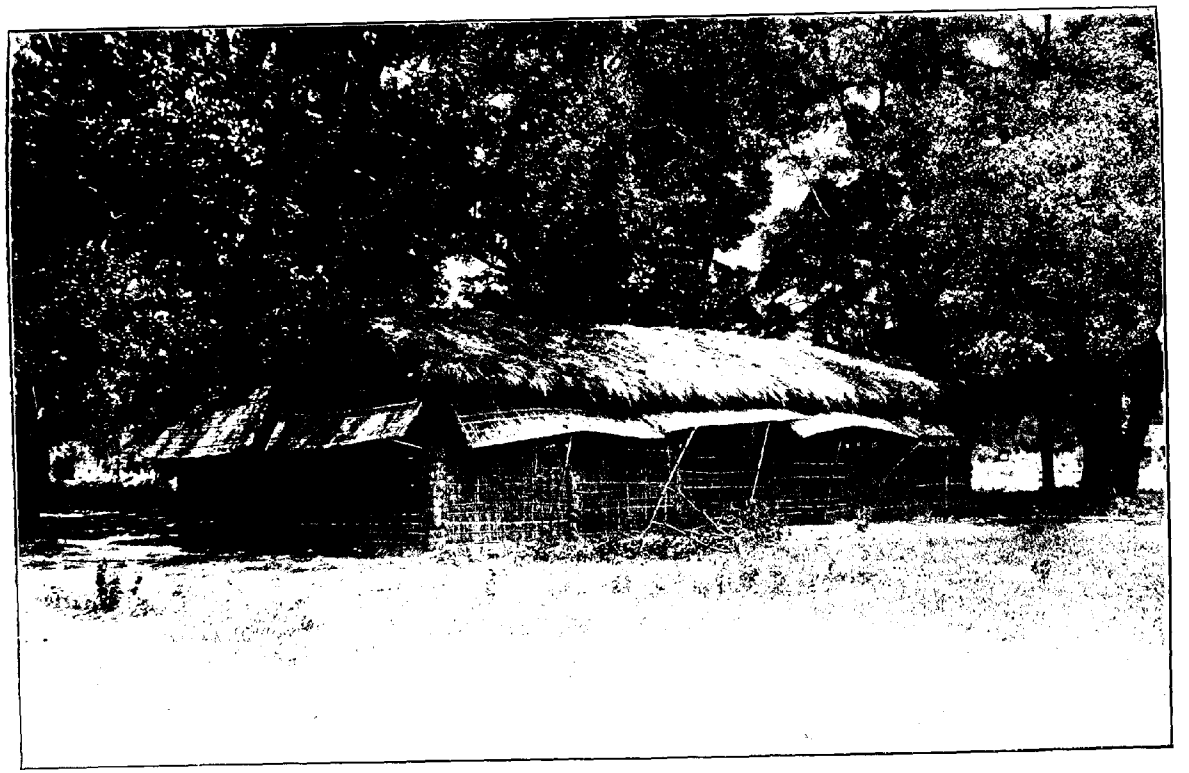
We here discuss eri silk solely from one point of view, its rearing and utilisation in this country by ordinary indigenous methods suited to any part of India. The question of building up an industry in this silk for export or for utilisation in India with power machinery for turning out the beautiful spun silks of commerce, is not here touched on, nor is the kindred question of producing reeled silk from these cocoons. The work of the past two years has been directed to ascertaining how far this silk can be utilised in India, and it is our belief that silk of this kind can be grown, spun and woven in a very large part of India, almost

PLATE VII

ERI SILK MOTH.

PLATE VIII.

PLATE VIII.

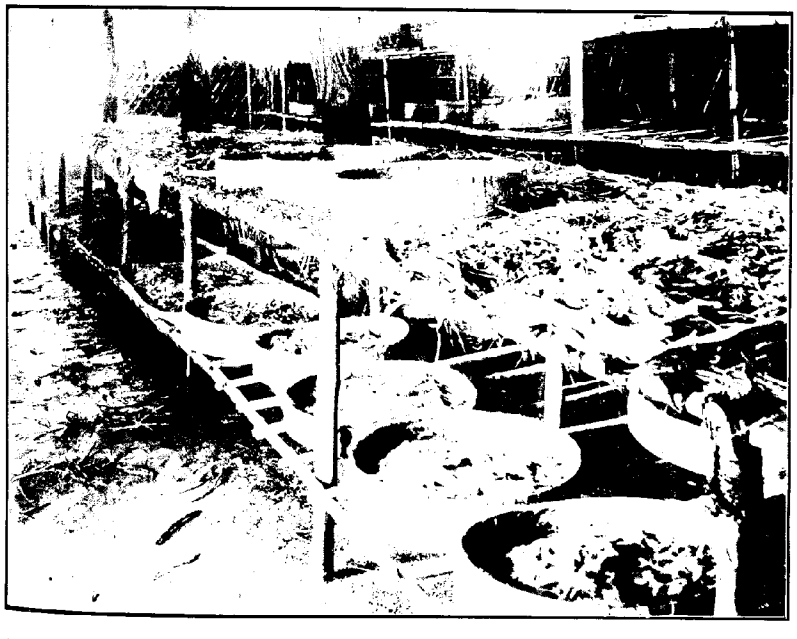


A. J. I.

REARING HOUSE.

PLATE IX.

End of Rearing House.



A. J. I.

Interior of Rearing House.

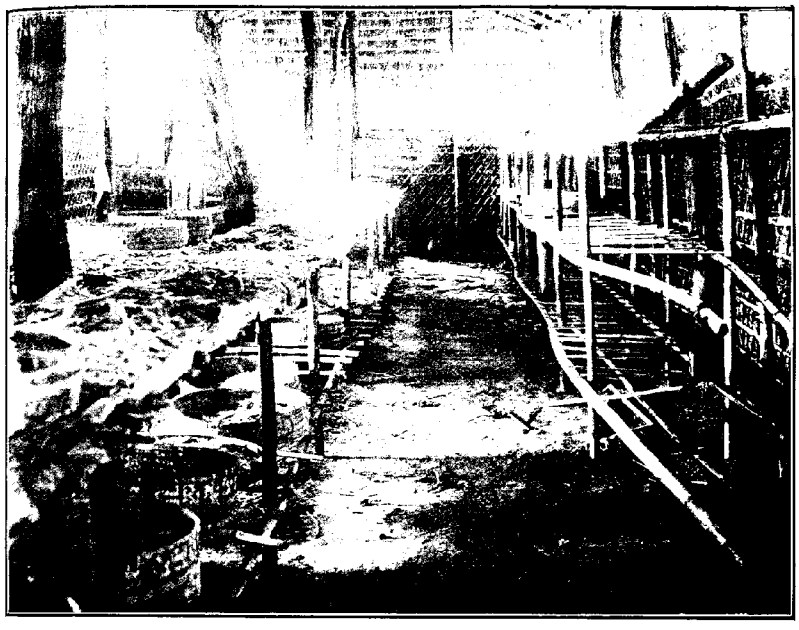
wherever the castor plant is grown. The eventual fabric thus produced is "Assam" silk, a very durable strong cloth, suited to the requirements of this country; but it must not be assumed that the finer silks of great delicacy and with beautiful gloss can be obtained. Fabrics more akin to cotton cloths are produced, but with the great durability characteristic of this silk, and by methods familiar in this country and requiring no appliances beyond those in ordinary use. It is impossible here to give detailed and complete directions for the cultivation of eri silk, but we deal with some of the more important points; anyone wishing to commence the cultivation can obtain eggs and fuller instructions from Pusa.

Rearing—The insect lives, as other insects do, in four stages; the moth lays eggs, which hatch to worms which feed on the leaf of the castor plant; the worms moult four times, at each moult increasing in size; when full grown (Plate VI), they retire into hiding and spin the cocoon; in this they change to the chrysalis, which lies motionless in the cocoon and requires no food; from this the moth emerges (Plate VII), which is of either sex; the sexes pair and the females lay eggs. The insects require attention in only two stages, the worm and the moth. The eggs are placed on a tray and left till they hatch. In dry weather they are covered with a damp cloth. When they are about to hatch, or when the first one is seen to hatch, they are covered with the youngest and smallest leaves of castor, spread out over them. They crawl up on the leaves and feed, and they can be removed attached to the fine leaves and put in a clean tray. As more hatch, the leaves are lifted and transferred. At first they are fed on the young leaves, washed free from dust if necessary. At intervals, moults occur, the worms ceasing to feed and throwing off their skin. This is a time when, if any are weak, they die. There are four moults before the last, the last occurring inside the cocoon. The full-grown worms, when ready to spin, become restless and move about; they are then placed in baskets filled with any convenient dry packing material, *e.g.*, the finely shredded wood used in packing delicate goods, wood-shavings,

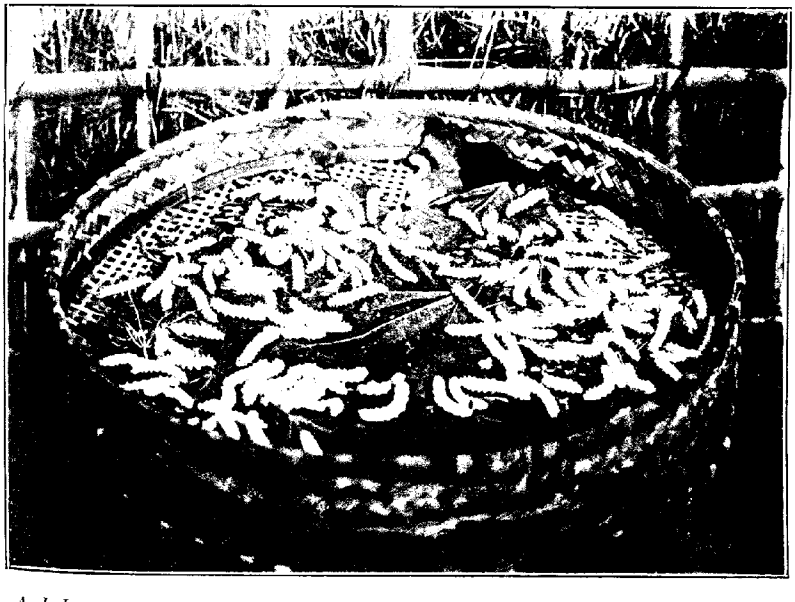
torn paper, dry straw or dry leaves (Plate XI). Into this they crawl and spin cocoons, first making a foundation, then spinning the regular cocoon inside. This occupies about three days; the cocoons are left for at least a week and are then picked out by hand (Plate XII) and laid out before the moths emerge. The moths emerge with crumpled wings and gradually spread their wings; they void a large drop of excrement, so it is advisable to let them crawl up off the cocoons (see special emergence tray, Plate XIII). The moths are then collected into baskets, where they couple. After twenty-four hours, the couples are separated, and the females put in other baskets to lay eggs, after which they die. The moths make no attempt to escape, and there is no need to confine them; but coupling and egg-laying are facilitated by placing the moths in baskets, to which they can cling and in which the light is not too bright. The moths lay, as a rule, from 200 to 300 eggs each, and if a large brood is required, all the eggs obtained may be kept for hatching; if not, only those from the best moths or only those laid on the first night (80).

In Pusa, seven broods are obtained during the year; in hot weather about forty-five days is the total length required for the egg, worm, cocoon and moth stages. This increases to as much as eighty days in the cold weather of January and February, when the worms feed less rapidly, and the moths take longer to emerge from the cocoons. The worms are resistant to all weather but to a dry, parching heat; in the hot weather when the west winds bring a temperature up to 110° F. with an extremely low humidity and an atmosphere laden with fine dust, the worms are less resistant to disease and may be unable to spin cocoons or to emerge as moths. At this time large numbers also fail to pass through the first moult. This is especially so if one has been rearing from too small an initial stock; "in-breeding" is as bad in this species as in others, and if there is a period of dry, hot weather to be passed through, the stock should be as vigorous as possible. It is, therefore, advisable to be able to introduce fresh stock at intervals, as can be readily done by obtaining fresh seed.

PLATE X.



Interior of Rearing House.



A. J. I.

Rearing Tray.

PLATE XI.

A. J. J. PUTTING WORMS TO SPIN.

The insect at Pusa is not subject to any of the usual silkworm diseases, but has a peculiar disease, allied to flacherie, but with symptoms and characters which, in the opinion of the Imperial Mycologist, separate it clearly from that disease. The experience at Pusa has been that it is better not to rear it at all during the hot, dry months or, if that is desirable, to rear only from good stock. As a supply of seed from Assam is now readily procurable, there is no reason for attempting to rear during unfavourable seasons. In Assam a parasitic fly attacks the worms, but if only eggs are imported and not cocoons, this pest will not be found and does not occur generally in India. The insect grows most favourably in a moist climate, whether hot or not, and could be grown during the rains practically all over the plains. It is unsuited to the plains of Northern India during April, May and June. Starting on July 1st with 1,000 eggs, one would have 900 moths by August 15th, yielding about 80,000 eggs, which would give a very large brood ; the rate of increase is so large and rapid that one can easily start afresh every season.

Appliances—In rearing, very few appliances are required. The rearing-house may be any roofed structure of grass and bamboos, with earth-floor. A large supply of trays, made of split bamboo or similar material, are required, some with fine mesh, some with coarse, open mesh ; the former may be smaller. In these the rearing is done, and one may keep the largest worms also in large rectangular trays of any size up to four feet by three feet. For the cocoons and moths, baskets are required and a supply of paper, shredded wood, straw or other clean material for the worms to spin in. We have also used the special emergence trays shown in Plate XIII, but it is not essential. The trays are placed upon *machans* of split bamboo (Plates IX & X), which may be covered with matting. The legs of the *machan* should be smeared with some sticky material if ants are a trouble.

Food—The worms are wholly fed upon castor leaves, plucked as required, and the castor plants msut be available close at hand. For young worms, small leaves are used, but later the large coarse leaves are required. Varieties of castor have been

collected at Pusa from all parts of India; some are better leaf-yielders than others, but all are eaten, the bronze or red ornamental variety grown in gardens being, however, disliked. The varieties in cultivation are apparently all suitable, some yielding more leaf than others. We are not here discussing the question of growing the worm on a large scale for factories, but rather of utilising available castor leaves, at present of little value, for producing silk. The best varieties for growing specially for silk and the best systems of plucking, etc., are under investigation at present. So far as can be seen at present, an acre of castor, not too heavily picked, should yield fifty to seventy-five maunds of leaf as well as a yearly normal crop of seeds. When castor is not available, the leaves of Ber (*Zizyphus jujuba*) can be used, and in Assam the leaves of Papaw (*Carica papaya*), Gulasiphol (*Plumeria alba*), Cassava and some trees are used, but not for rearing on any scale, only to keep a few worms alive from season to season.

Utilisation of the Silk—The cocoons, after the moth has emerged, are collected; they sell at present for about Rs. 70 per maund in Calcutta, but can be more profitably grown for local use. Of good cocoons, 2,500 go to a seer; of small ones, as many as 4,000. It requires 75 lbs. of castor leaf to feed the number of worms, large or small, which produce a lb. of cocoons. A seer of cocoons, after treatment, yields about twelve chittacks of thread (75%). The cocoons are, in Assam, both brown and white; in Pusa, by rearing from white cocoons, or from some other cause, only white cocoons are obtained; the colour is immaterial as, in the boiling off, the brown of the cocoons is dissolved off. The cocoons are boiled in water containing either castor ash or soda. Castor ash, *i.e.*, the ashes of castor stems and branches, contains about 28% of Potassium carbonate; on boiling the cocoons in water containing a seer of ash to each seer of silk, with enough water to cover the cocoons, the gum on the thread is dissolved and the cocoon becomes soft. In using soda, one takes for each seer of silk a quarter of a seer of soda and boils for three-quarters of an hour, and this is the best treatment.

PLATE XII.

A. J. I. PICKING OUT THE COCOONS.

The cocoons are then washed and are ready for spinning. Spinning may be done on the usual spinning wheel (*Charka*) used for cotton, from either the wet cocoon or from the dry one, or on the Taku, used in Assam for this silk (Plate XIII). One method is simply to spin from the wet cocoons, the spinner taking a lump of them in one hand. Another is to dry the boiled cocoons, and to card out the silk into a mass like cotton or wool, loose, dry fibres, and spin from that. The former gives a finer, closer thread of dirty colour, the latter a white, fluffy thread less suited to fine weaving. The latter thread is readily made by those who understand wool-spinning, as in the Punjab. An improvement in spinning has been effected by the use of a new machine, in which the spinning is continuous by means of the "flying needle" and is done on to bobbins direct. This machine has been worked out at Pusa and is in use there. It facilitates the spinning of coarse thread suited to the requirements of the country, and is a simple machine easily made and worked.

The thread produced is woven in the usual way and is suited to the handlooms of this country. A variety of looms are being employed, but we have nothing original to offer on this subject, and the usual method of weaving may be adopted. In this way, by using either the ordinary spinning methods used for cotton, or by using the new machine, and by utilising the ordinary weaving of the district, one can produce good durable cloth, of a white or écru colour, either fine or thick, with great durability and wearing qualities. The silk has not the appearance of the fine reeled silks ; it has not the gloss and the sheen, but is best described as being the familiar Assam silk.

The dyeing of this silk is easy ; the indigenous dyes of plant origin are especially suited to it ; alizarine or anthracene dyes give brilliant and fast colours ; aniline dyes give a large range of brilliant colours ; some fairly fast, some fugitive. The cocoons may be dyed or the cloth, and a great variety of colours, fast to light, can be produced. Careful tests have been made of a great variety of dyes and, while the ordinary methods of using indigenous plant dyes for silk are applicable to this silk, we would

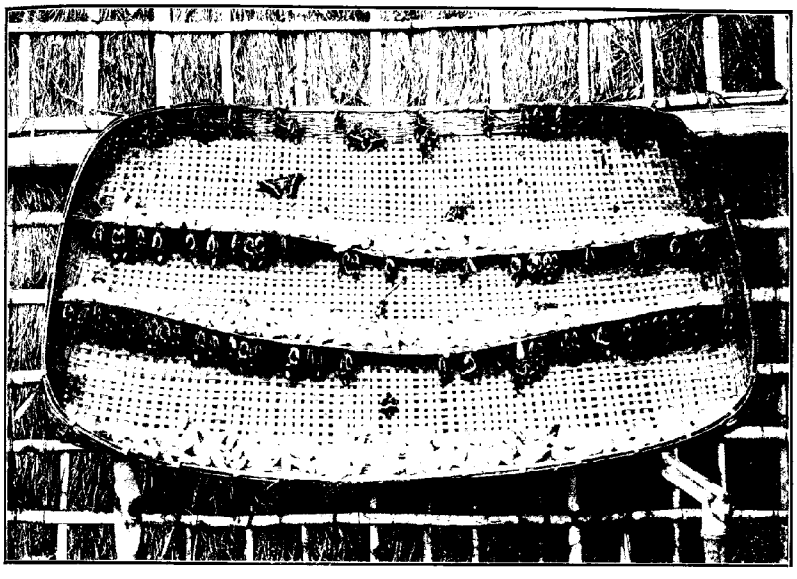
urge the use only of fast dyes, whether indigenous or not. It is impossible here to enter further into this question, but there are no special difficulties in dyeing, and full information can be obtained from Pusa. Good fast colours are obtained with indigo, lac-dye, backam, palas, manjista and jackwood, among indigenous colours; with the alizarine (mordanted) dyes and with some aniline (acid, direct or developed) colours. The reader may consult Bannerjee's *Dyeing in Bengal* or E. R. Watson's *Fastness of the Indigenous Dyes of Bengal* (*Memoirs*, Asiatic Society of Bengal, Vol. II, No. 7, p. 155).

Eri as an Industry—At the present time, eri silk is grown in Assam partly to supply clothes to the grower, partly to satisfy a demand for Assam silk cloth, produced at factories in Gauhati and elsewhere. We believe there is a large field for its extension, as a minor or home industry, wherever castor grows in India: the seed is obtainable and is readily sent by post to all parts of India; the rearing is simple and can be done on a small or large scale once it has been seen; the production of thread and cloth offers no difficulties to people accustomed to spinning and weaving cotton; and there is no inherent difficulty which would prevent its adoption in all parts of India where castor is grown and where the climate is suitable. The culture of the worm on a large scale, or its utilisation on a large scale in power looms, is a matter of commercial enterprise and not our immediate concern. Where castor is available, large quantities could be produced and either spun or woven locally, or collected and utilised in a factory.

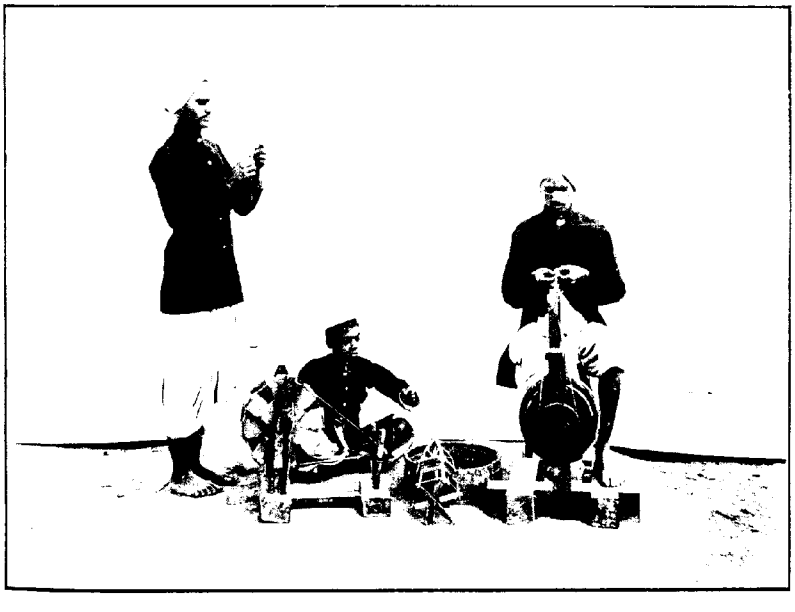
In Behar, the cost of producing the cocoons, spinning the thread, and weaving the cloth, totals up to much less than the market value of the cloth, though full wages are paid to the rearers and spinners; where the rearing and spinning are done by whole families including women and children in their leisure time when fieldwork is not pressing, it represents a valuable minor industry.

At the present time, the seed is obtainable only from Assam or from Pusa. We would emphasise the very grave danger of obtaining live cocoons from Assam, since they carry the parasitic

PLATE XIII.



MOTHS EMERGING.



J. J. J. SPINNING.

On the left the Taku, the Charka in the middle, and the Pusa Continuous Spinning Frame on the right.

fly, the most dangerous enemy to the worms; and, as a rule, seed obtained in the ordinary way from Assam is bad. Good seed will be sent from Pusa, and, if notice is given, a large supply of seed is usually available. A limited number of men, trained to the work, are available for starting the industry in new places, and anyone wishing to learn it can be taught in the Pusa rearing house in a short time. The industry is being taken up in different parts of India, and wherever there is a demand for light remunerative work, such as can be done by women and children, if castor is available, the rearing, spinning and weaving of this silk offer many advantages.

THE MANAGEMENT OF EXPERIMENT STATIONS IN INDIA.*

I.

By W. H. MORELAND, C.I.E., I.C.S.,

Director of Agriculture, United Provinces of Agra and Oudh.

All administrative officers will sympathise with Mr. Standen's desire that Experiment Stations should be worked as economically as possible, and that their arrangements should not be such as to give an impression of lavish expenditure. I fear, however, that the remedy he proposes—the striking of a balance-sheet for non-experimental operations—involves considerable risks. For one thing, there is the danger that officers outside the department may attach undue weight to the balance-sheet, and that when provincial resources are depleted, the department may be called on to improve its contributions under penalty of a reduction in its grants. This is not a fanciful danger: a leading agriculturist in Australia told me some years ago that the whole department in one Australian State was crippled by the obligation to show a profit on its farming operations; and though an Indian Provincial Government is not likely to put the matter so crudely, Resolutions and Reviews, which should pass lightly over the experiments, but comment favourably or unfavourably on the financial results, might have a most insidious effect on the managing staff.

Even if the balance-sheet were treated as a departmental secret, I fear it would still have an injurious effect: the

* In Vol. III, No. IV of this Journal, Mr. Standen wrote an article on the above subject and we, in a note, invited criticisms on it. The present articles are written in response to that.—Editor.

subordinate staff of an experiment station must give its attention first to the experiments, and it would be trying the staff rather highly to require them to show a profit at the same time. There would be the temptation to scamp a laborious piece of experimental work in order to get the profit-making crops into the ground, or to harvest perishable crops quickly, or to perform any of the numerous agricultural operations where the right time is everything ; and even if the temptation were resisted, there would still be an undesirable diversion of interest from the main object of the station.

Again, the distribution of the expenditure would, as Mr. Standen recognises, have to be largely arbitrary, and there would be a wide scope for that unprofitable hair-splitting in which many Indians (and Englishmen too for that matter) are so fond of indulging, the general aim being to throw all possible items into the experimental account. This would involve, I fear, a considerable amount of time spent in book-keeping by the responsible officer in charge, who could usually employ his time more profitably.

Lastly, I cannot share the hope implied by Mr. Standen, that the accounts of the non-experimental work of an experiment station can demonstrate that high farming on a capitalist basis is a paying enterprise. It would be straying too far from the question under discussion to consider the best form of such demonstrations : in some parts of India at least, they must be preceded by experiments to decide whether or not such farming can be profitably carried on : but my present point is that the limitations of an experiment station are all against a real demonstration of profitable high farming. Such a station will ordinarily include (*a*) a small area under experiment ; (*b*) a larger area awaiting new experiments ; and (*c*) an area (which will, for some time, increase in size) recovering from closed experiments. Now, the treatment of the land awaiting experiments is a matter of the utmost importance : the object should be to have as many blocks as possible of *approximately uniform productivity* ; and this involves the

determination of yield in very small sections (a most expensive operation); and also I think a very sparing use of manure except on the land that is not uniform at the start. And the treatment of land after experiment must, in the same way, be adapted primarily to make it fit for fresh experiments (a tedious matter where the manurial treatment has been differential). It seems to me that these conditions of work are not compatible with a demonstration of profitable high farming.

In practice, then, we must, I fear, be content with an approximation to Mr. Standen's ideal. For one thing, areas occupied by demonstrations should be clearly separated from experiments, as was recognised by the Board of Agriculture in 1906; and ordinary cultivators should not be encouraged to visit the experimental area. But as unskilled visitors cannot altogether be excluded, I suggest that some restraint should be exercised in laying out experiment stations, and that proposals for heavy initial expenditure should be considered not from the point of view of convenience or appearance, but from that of indispensability for experimental work. It will probably be found that buildings erected in country fashion by the staff will serve most purposes: that the manure can be effectively conserved by methods within the reach of cultivators: and that most of the tillage can be done by the cattle of the locality.

II.

By C. BENSON, M.R.A.C.,

Late Deputy Director of Agriculture, Madras.

In the October number of the *Agricultural Journal of India* you invite criticisms of Mr. Standen's article on the "Management of Experiment Stations," and though I am no longer concerned in the matter, I still venture a few remarks thereon.

Mr. Standen starts by defining the object of such stations as being to 'solve certain problems of sufficient importance to warrant the expenditure of public money,' and then proceeds to

describe how at 'many, perhaps the majority, of the experiment stations in India' the area taken up is far larger than is needed for the conduct of the experiments designed, and how such a station is, in fact, a highly cultivated farm, equipped and staffed on an expensive scale; and he then urges that 'there is a danger that the perfection of the buildings, stock, etc., may diminish the practical value of the experimental work' thereon. He, therefore, puts forward the proposition that 'in designing an experiment station, it should be borne in mind that, after making allowance for the staff and buildings required for the experimental part of the area, the value of the produce of such parts of the farm as are not used for experiment should be sufficient to cover the cost of management and cultivation, including interest and depreciation on cost of buildings and to yield a substantial profit besides.' At the close of his article, however, Mr. Standen adds a rider which shows that he recognises that the management of such stations must not be to risk their main objects in the pursuit of 'profit-making.' This is, however, rather by the way of 'hedging' on the main contention.

It may be admitted that, if it is unavoidable in designing an experimental station, areas so large as Mr. Standen mentions should be taken in, some plan must be evolved for combining 'profit-making' or commercial farming with experimental farming, even though no one would be convinced by results achieved by book-keeping, whilst the people of Southern India say that 'keeping accounts is possible in trade, but not in agriculture.' It must also be admitted that commercial undertakings in almost all cases, and commercial farming in particular, cannot be undertaken satisfactorily by the State, or at least, if undertaken by the State, must prove far less remunerative than when in the hands of private individuals. In the case of a farm conducted for 'profit-making,' the commercial result depends most frequently on the business aptitude of the manager, as a buyer and seller; that is, as a trade, and not on his skill as a cultivator. And as a trader on behalf of the State, the manager of an experiment station is handicapped, and handicapped heavily, if

not fatally, in all his operations which are, moreover, limited and circumscribed by the methods of the account department.

But the idea that a State farm should be managed with a view to profit-making, seems to me a mistake. I once held ideas somewhat similar to those set out by Mr. Standen, but experience taught me otherwise, and I believe that endeavours to pursue that course would end in a great waste of time and public money, and set back the really valuable work of the experiment stations. Although, 'cultivation is like a stone in a madman's hand' in respect of the results that the cultivator may achieve, and one cannot, of course, go so far as to say, as is said in Madras—

> If the ploughman count the cost,
> Even his ploughshare will be lost,

in the case of some State-managed farms a profit may be fairly worked out by its books; such a case will always be exceptional and will occur where a farm is devoted not to general or typical farming, but to the cultivation of some one or two very valuable staples. On the other hand, there are some staples demanding attention and work on, perhaps, a farm of the size Mr. Standen mentions from which at present it would be hopeless to expect commercial returns on a State-managed farm, and the pursuit of 'profits' would probably wreck the whole work. I say this because, if profit-making were to be considered at all, official and public attention and criticism would in almost all cases be centred on the immediate 'financial' results, and the farm managers would be led to concentrating their attention and energies on this aspect to the detriment of the infinitely more important object or objects for which the farm was established; and this too in pursuit of a chimera, if for no other reason because on a public farm there must be a regard for appearances and a lot of 'eyewash' is required to meet uninstructed criticism, and this costs money, whilst on such a farm the manager cannot leave undone or postpone to the most convenient season the thousand and one things that the ryot or private individual would.

But, be opinion on these points what it may, Mr. Standen's article appears to me to be a most damaging criticism of the

manner in which 'many, perhaps the majority, of the experiment stations in India' have been started, in that he shows most conclusively that for their objective 150—200 acres is a far larger area than is required. In so far as this presentation of the facts is accurate, I believe that he is quite correct, and that such farms, in general, are a mistake and a most expensive one. There are, no doubt, circumstances which justify the taking up of so large an area with a view to the production of good seed, but that is another matter from experimental farming, and there seems to me to be no necessity for making experiment stations more than, in general, 40—50 acres in extent, though the area must vary with local conditions, and in some cases they might be much smaller. Such areas* would provide for the experiments designed at the starting of the station and for their almost inevitable expansion as time goes on. Although India is a country of small and of very small holdings, it must be remembered that the ryot in his cultivation does a great deal of co-operative labour, and thus the economic difficulty of working such small areas as he usually deals with is got over, but this kind of work is not possible for an experiment station, and it is necessary that its area should be such as would allow of a minimum of two pairs of cattle performing all the work thereon. More than this would entail unnecessary expenditure, both of capital and in recurring charges.

Should experiment show that it is advisable to extend operations so as to admit of producing high class seed, it is possible that the commercial idea might be allowed to prevail, but then would arise the very difficult question of determining the value to be put on such produce before the accounts are made up, for it is questionable whether the ordinary cultivator has as yet conceived the real value of such supplies, or would give them for State-grown produce.'

It should also, I think, be recognised that an experimental station should not be looked upon as a place to which the uninitiated should be asked to resort in order to see the wonder-

* It must be remembered that no inconsiderable area will go out for roads, buildings, etc., and that the experimental area must be select; thus only odd corners will be left.

ful things that the 'Sirkar' is accomplishing—that would connote the ancient and exploded idea of 'Model' farming—but should be devoted to experiment only. And it is here that Mr. Standen seems to show a confusion of ideas; for experiment is one thing and demonstration is another altogether, and it appears to me essential, if good results are to be expected, to keep the two separate and apart.

In the matter of demonstration, it also appears to be essential that the fact that what is possible and possibly advisable on a farm of 150—200 acres is often neither possible nor advisable on the minute holdings typical of the country at large. I would also suggest that there should be no greater difficulty in demonstrating the effect of the more thorough application of practices now in common use, than in demonstrating new methods—both may be matters of considerable difficulty and either may be very easy.

At first sight, then, there appears to be much to commend itself in Mr. Standen's contention as to the advisability of considering in the case of experiment stations in India the commercial side of their farming operations, but, if more deeply-considered, it will, I believe, be found that it is based on a confusion of ideas and an assumption which is not tenable; whilst, if the assumption were admitted to be acceptable, I doubt, first, whether the idea he contends for is feasible, and, secondly, even if it is feasible, whether by any mere book-keeping the object he holds in view would be attained.

HINKIPU, HEAVITREE, EXETER,
26th Jan., 1909.

III.

BY H. C. SAMPSON, B.SC.,

Deputy Director of Agriculture, Madras.

REFERRING to Mr. Standen's article on the 'Management of Experiment Stations' in the October number of the Journal,

the writer is evidently exercised in his mind—and in my opinion rightly so—on the different conditions under which an Agricultural Station, such as he describes, is worked from those under which the ordinary cultivator has to work. Certain conditions must be different. A cultivator's time is his own, and his wages are the crops which he reaps, but on an Agricultural Station much of the labour has to be hired and paid for, no matter what the weather or work to be done is. The ryots' cattle are his own, and he can hire them out or use them for carting on the roads when they are not wanted on the land, and can thus often pay for their keep ; but on an Agricultural Station the bullocks can only be used for the work connected with it. Thus the cost of cultivation of a crop on an Agricultural Station may in accounts show a loss, while under similar treatment in a ryot's hands there might be a considerable profit. Cattle-sheds, again, are in many districts quite a new idea. In some places, the animals are treated as members of the family, or in other places, are tied on the verandahs, but such buildings, even though they are designed and constructed as simply as possible, are essential on an Agricultural-Station. The seed-store is another building which is essential, and it is also essential that this should be dry and well ventilated, especially if the Agricultural Station undertakes the sale of seeds, but with these exceptions the conditions should, as far as possible, be the same as those under which the ryot works. As the writer of the article implies, the Agricultural Department is meant for the benefit of the cultivator, and one is, perhaps, too apt to forget what the cultivator is. In the majority of cases, he is illiterate. He is bound to the customs, superstitions and traditions of his own village. If you ask him whether he has ever tried this or that practice, he may say that they do it in the next village, but it is never done in his own. Yet it is possible, if such a man visited an Agricultural Station and was not distracted or bewildered by the lavish expenditure on buildings, machines and cattle, and if he were to see the two crops growing side by side under similar conditions that he might change his method if he saw that it was to his advantage. There

are experiments which a cultivator can understand and can learn from an Agricultural Station, and until he has been educated up to even this point, the experiments should be confined to such and similar experiments which the Deputy Director should be able to devise with his knowledge of the whole Division, his scientific training and the assistance which he should be able to obtain from the results of the research side of the Agricultural College and Central Experimental Station. Afterwards when the ryots' confidence has been won, other experiments dealing with slightly more complicated problems could be introduced, but they should always be such that the object of these can be intelligently explained to the cultivator. The man whom the cultivator would ask about the experiment would not be the Deputy Director of Agriculture, nor would it often be the Manager, but usually it would be the cooly who works on the farm. If this man cannot explain, how is it expected that the casual visitor will understand? It stands to reason that the farm cooly should be the exponent of the experiments to cultivators. He is one of themselves, he knows their difficulties as his own. He is not newly imported into the district, and he can make a very shrewd guess as to which method or experiment is likely to be most profitable. Then, again, when a thing has been proved by experiment, it is most essential that it should be demonstrated and again compared on a larger scale, and such demonstration should, in my opinion, be always done on the Agricultural Station where the experiment was originally carried out, even though other demonstrations may be conducted in other parts of the district. For this reason alone, it would not be possible to work the 'non-experimental' area solely for a profit.

The writer of this article gives one the idea that in starting an Experimental Station it is possible to fix definitely the lines of experiments which are to be conducted, and that when these are once started, the only thing is to work out and tabulate the results. If this is his idea, I cannot agree with him. The more one studies the crop on the farm and tours in the tract that the Station is meant to represent, the more one feels how only the

fringe of the question has been touched upon. Under these circumstances, it seems to me that the experimental area must change. Fresh experiments must be taken up, and old ones which are never likely to give any practical results must be given up.

If an Agricultural Station is to be run on the above lines or any lines, I do not see how any adjustment of accounts will ever do any good. If the cultivator cannot understand the object of expenditure on buildings, implements and cattle, how is he to be expected to understand account adjustments? If you can say to him that this plot or field under this treatment gave a crop worth so much, and the net profit after paying for all the cultivation, seed, manure, harvesting and threshing was so much, he can understand that, and the system of keeping cultivation sheets as adopted on the Agricultural Stations in the Madras Presidency seems to fulfil all requirements. These cultivation sheets are kept for every field and plot, whether experimental or not, as long as they are under cultivation. They are posted up periodically like a ledger, the cash book being the Daily Record sheet which shows all cooly and cattle labour and all money transactions for each day. Specimens of these are enclosed.

Many may say that there are problems which require solving which would be wholly unintelligible to the cultivator. Granted that this is so, but is an Agricultural Station which is in charge of a Manager and which is only periodically visited by the Deputy Director, the best place to do this? Surely, in the present state of agricultural advancement such intricate problems should be done on the Central Agricultural Station attached to the Agricultural College. The site of this, one may take it, has been carefully chosen so as to represent as many local conditions as possible. Every experiment is under the direct charge of the Superintendent who is himself a trained officer, and there is every facility for the co-operation of the expert officers of other branches of science who are also stationed there.

DAILY RECORD SHEET.

DAILY RECORD OF THE KOILPATTI AGRICULTURAL STATION.

AREA.

LABOUR.

Field or Head.	Nature of Work.	Cents.	PERMANENT COOLIES. AS. 4½	AS. 4	AS. 3½	CASUAL COOLIES. AS. 3½	AS. 3	AS. 2½	AS. 2	Pair of cattle.
Yard	Attending to cattle, cattle-hed, &c.	...	...	...	...	..	1	½	...	...
Maintenance of cattle	Cutting grass for cattle ..	...	...	...	...	...	..	...	10	...
3. Raggi	Irrigating ridge portion whole water used 1,012½ c. ft.	·35	...	...	5/8	...	...	...	5/8	5/8
	Irrigating beds, a portion only, water used 900 c. ft.	·18	...	...	1/3	...	...	...	1/3	1/3
4. Cowpea varieties	Collecting pods	...	...	...	...	...	...	...	1	...
4. Do. do. ...	Handpicking bags	...	1	...	...	...	...	...	1½	...
5B. Raggi	Irrigating (irregular portion)...	...	...	...	...	1	...	...	1	1
9B. Sweet potatoes...	Clearing water channels preparatory to irrigation.	...	...	...	...	...	...	½	...	...
22. Cotton ...	Weeding and thinning ...	2·00	...	..	...	...	...	...	11½	...
22. Do.	Dibbling seed in blanks ...	2·00	...	...	...	...	1	1	1½	...
22. Do.	Working bullock hoes ...	1·50	...	¼	...	½	...	...	...	¼
24. Do.	Do. do. ...	...	...	¼	...	1½	...	...	...	¼
Miscellaneous cultivation expenses.	Head cooly supervising work...	...	1	..	...	...	...	...	...	...
Maintenance of cattle	Grazing cattle	...	...	...	...	...	...	...	1	...
	TOTAL ...	...	2	1	1	3	2	2	28½	3

DATE 18-11-08.

MANAGER'S DAILY NOTES.

Charges.

	Rs.	A.	P.
Freight on parcel of maize seed from Nellikuppam	1	0	0
Wages to coolies for the week (12th to 18th) ...	45	8	3
Advance to coolie, Vellayan	1	0	0

Charges under improvement of cotton cultivation grant.

Wages ...	15	3	6

Assistant Manager, Venkaswami Rao, left this station on tour to Perambalur.

(Sd.) A. V. THIRUMURUGANATHAM,
Manager.

CULTIVATION SHEET.

KOILPATTI AGRICULTURAL STATION. CROP—UPPAM COTTON, 1907-1908.

No. of plot or plot subdivision.	AREA OF PLOT.		YIELD OF CROP.			VALUE OF PRODUCE.		COST OF PRODUCTION.		
	Acre.	Cent.	——	Per plot.	Per acre.	Per plot.	Per acre.	——	Per plot.	Per acre.
				LB.	LB.	Rs. A. P.	Rs A. P.		Rs. A. P.	Rs. A. P.
Field 21 ...	8	20	Produce Kappas ...	5,220½	636½	424 7 8	51 12 3	Preparatory Cultivation	44 4 6	5 6 5
								Manure	26 5 8	3 3 5
								Seed	3 0 0	0 5 10
								After Cultivation ...	35 4 0	4 4 9
								Irrigation	... ...	.....
								Harvesting, Threshing...	63 14 11	7 12 9
								Total ..	172 13 1	.....

CROP—UPPAM COTTON. KOILPATTI AGRICULTURAL STATION, 1907-1908.

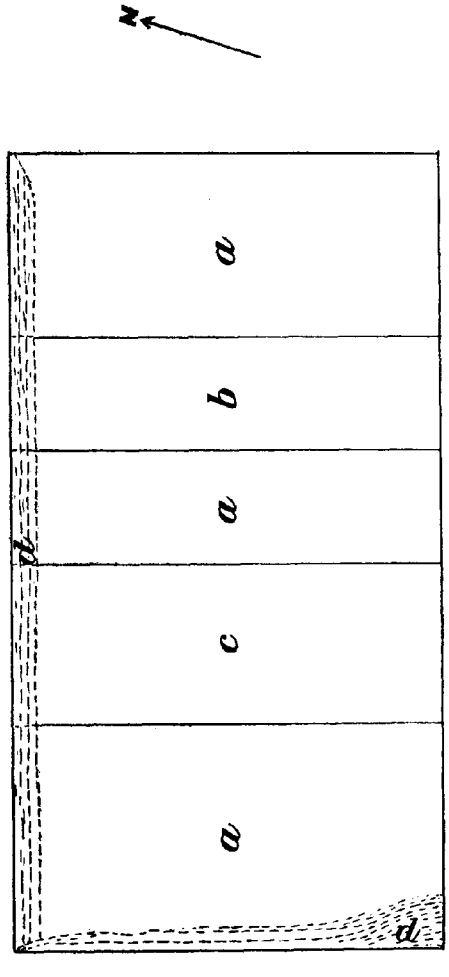
Date.	Description of work.	Men.	Women.	Boys.	Bullocks.	Cost of work. Rs.	A.	P.
20-2-07	Working blade cultivator after harvest, 5 acs.	2	...	...	2	1	8	0
21-2-07	Do. do. 1·60 acs.	2	...	...	2	1	8	0
21-2-07	Do. do. across 3·50 ,,	2	...	...	2			
26-2-07	Do. do. do. 4·40 ,,	1	...	...	1	0	12	0
19-3-07	Do. do. do. 3 ,,	1	...	...	1	0	12	0
27-5-07 & 1—4-6-07	Working cotton soil plough whole area	34	...	...	34	25	8	0
29—31-5-07 1—3-6-07 & 15—17-6-07	Sheepfolding (6,918 sheep)	...	...	...	...	20	11	8
Same dates	Guarding and watching sheep	24	...	...	...	5	10	0
8—10-6-07 & 18—20-6-07	Ploughing the whole area to cover sheep dung, etc.	11½	...	...	11½	8	7	0
22-6-07	Working blade cultivator over whole area	2½	...	...	2½	11	11	0
6-10-07	Removing rank weeds preparatory to sowing	...	4½	...	...	0	9	0
17-10-07	Sowing cotton (80 lbs. seed) with drill covering with blade cultivator	6	...	...	4	3	7	6
17-10-07	Removing rank weeds preparatory to sowing	...	1	...	...	0	2	0
19, 22 & 23-11-07	Filling up blanks with seed	5	7	...	...	2	0	9
24-11-07	Thinning plants	1½	...	...	...	0	5	8
23, 26 & 28-11-07	Weeding and collecting weeds	2	19	...	...	2	13	6
22-11-07	Working blade cultivator to remove plants into the area to be resown, 1·10 acres	½	...	...	¾	0	6	0
23-11-07	Resowing and covering, 1·10 acres	1¼	...	...	¾	0	10	11
3, 4-12-07	Second thinning	⅜	12	...	...	1	10	9
3-12-07	Hand weeding in the rows (contract) whole area	¾	40	...	...	5	0	0
3, 4-12-07	Working bullock hoes	5	...	...	2¾	1	15	6
22-12-07	Ditto 3 acres	1½	...	...	¼	0	9	9
23-12-07	Ditto rest of area	3	...	...	1	1	3	6
27-12-07	Ditto (resown portion 1·10 acres)	½	...	...	⅛	0	3	3
27-12-07	Thinning ditto	...	½	...	...	0	4	0
4, 5-1-08	Weeding in the rows	⅛	6	...	...	0	13	11
5-1-08	Second thinning (resown portion) 1·10 acres	½	½	...	...	0	5	11
7, 8-1-08	Weeding in the rows, 5½ acres	1	24½	...	...	3	4	9
9, 10-1-08	Working bullock hoes	4½	...	...	1⅛	1	13	3
22, 23-1-08	Ditto	5½	...	...	1⅜	2	1	2
3-2-08	Thinning resown portion 18" apart as per Deputy Director's order	1	5	...	...	0	13	9
22-2-08	Working bullock hoe, 1·10 acres	½	...	...	⅛	0	3	3
2-3-08	Picking stray kappas	...	1	...	...	0	2	0
8, 10, 12-3-08	Removing hariali grass in patches	1	27	...	...	3	9	7
11-3-08	Working bullock hoe, 1·10 acres	¾	...	...	¼	0	4	9
12, 13, 17, 18, 21, 23, 25, 26, 28, 29, 31-3-08	Picking kappas	3	94	...	...	12	7	4
1, 6, 7, 8, 9, 10, 11, 16, 17, 18, 21, 22, 23, 24, 25, 26-4-08	Ditto	17	253¾	...	...	35	11	3
	Total	...	...	...	...	149	8	8

CROP—UPPAM COTTON. KOILPATTI AGRICULTURAL STATION, 1907-1908—*concld.*

Date.	Description of work.	Men.	Women.	Boys.	Bullocks.	Cost of work. Rs.	A.	P.
27-4-08	Working bullock hoe, 8·20 acres	6	...	...	2	2	7	0
2, 3, 15, 28-5-08 13, 14, 22, 23, 28-6-08 1, 4, 5, 10, 11, 19-7-08	Picking kappas	½	74¼	...	...	9	6	4
19, 20-5-08	Working bullock hoe	5½	...	...	1½	2	3	1
	Pulling out cotton plants and stacking the same on the field (8·20 acres) piece work	...	...	...	...	6	4	0
	TOTAL	...	...	...	...	169	13	1

Date.	Descriptive notes on the crop.
	Date of sowing ... 17th October 1907 (1·10 acres resown 23rd November 1907).
	Date of flowering ... Commenced about 20th January 1908.
	Date of harvesting .. Picking kappas commenced 2nd March 1908. Season picking over by end of April. Summer picking from 13th June 1908 to 19th July 1908.
22-10-07	Germination good and uniform.
30-10-07	A kind of grey weevil which has become a pest this year has caused many blanks, eating away the young shoots which have not for the secondary leaves.
5-11-07	Too much rain has also added blanks. Several young seedlings have rotted and died. Blanks will be filled up when fine weather sets in.
25-11-07	Blanks have been filled up by planting seed and in a portion where there were too many—resowing was done, being found economical.
25-12-07	The crop is doing well. Weeding was done with more labour than usual, conditions having been favourable to the growth of weeds and untimely for their favourable removal.
5-1-08	As is characteristic of Uppam, the field at present looks healthy and vigorous and is steadily progressing, the weather having been clear and almost rainless.
20-1-08	The recent rains have done much good ; no more will be required till the 1st picking is over. It is now flowering here and there.
29-1-08	Here and there some caterpillars (leaf-eaters) and horned bugs are noticed, but the present conditions of the weather do not appear to favour their increase. The plants are here and there attacked with Buttermilk disease.
9-2-08	The crop is growing, and flowering is general on the high ground.
1-3-08	Flowering general, except in resown portion. Stray bolls are bursting. It is to be noted that this field, though sown at the same time as Nos. 27 and 28, is more than a fortnight later. Here and there occur intermediate plants known as "Vellai Karunganni." The late sown portion has been thinned and reserved for Professor Gammie's selection of typical plants.
30-3-08	Heavy picking. The plants are bending with the load of bolls. A good crop is expected. Recent rains hampered picking considerably.
27-4-08	The plants have flushed for the summer picking.
15-7-08	The summer picking is almost over ; the yield is disappointing.

Map Sheet of Field No. 21, for the Uppam Cotton Crop, Koilpatti Agricultural Station, 1907-1908.



29th January 1908.

a. The plants are tolerably good though not uniform in height.

b. Resown portion. The crop here is not so advanced as the remaining portion—here too the northern strip is sparse.

c. The plants are healthy, uniform and vigorous.

d. This portion is patchy owing to surface wash and stagnation of water. There is a band of land across the N. and W. boundaries where the crop is thin. The plants too are stunted and puny and have not grown well.

SUGAR-GROWING AND MANUFACTURE IN NORTHERN INDIA.

By C. J. MACKAY,

Superintendent, Cawnpore Sugar Works.

Several attempts have been made in recent years to manufacture white sugar direct from sugar-cane as is done in the West Indies, Egypt, Mauritius and other sugar-growing countries.

Considerable capital has been invested in these undertakings, the best up-to-date machinery imported from Europe, and skilled Europeans with expert knowledge, commercial, technical and scientific, have been employed. In spite, however, of what would appear to be most favourable auspices, careful supervision, and a very large demand for the manufactured article, none of these undertakings have so far achieved more than a very moderate success, and most have had to face serious pecuniary loss.

At first sight, no country in the world would appear to offer a better field for the cane and sugar industry than India. The consumption of sugar by the inhabitants of this country is enormous, and upwards of half a million tons of sugar are imported into India annually.

Why then has the sugar-making industry not made better progress? Various causes have contributed to handicap these pioneer efforts. Although sugar-cane has been grown throughout Northern India for some 2,000 years, the quality of the crop has never been as high as in other cane-growing countries, either as regards the weight of cane grown per acre or the sugar contents per 100 of canes.

The Indian cultivator, at his best, is hard to beat, although his methods and implements may appear primitive to Western agriculturists. He is quick to adopt improvements in cultivation

and seed, if he is satisfied that they will increase his profits; but in the growing of sugar-cane, he is faced with two serious problems.

The soil has been exhausted by many centuries of continuous cropping, and the supply of suitable manures at a moderate cost is very limited. A greater difficulty still is the climate. The annual rainfall, though usually sufficient in quantity, is badly distributed throughout the year, being concentrated into a few months, followed by many months of extreme dryness.

These two causes, however, would not alone be sufficient to account for the indifferent success of large central cane factories: fresh sources of manure can be discovered, and the short period of growth, due to the concentration of the rainfall, can be mitigated by carefully thought-out schemes of irrigation.

The Indian cane factory has against them, on the credit side, the saving in manufacturing losses by a continuous process, and the economy in freight and transit charges by having a ready market at their doors.

The greatest difficulty, however, with which a central cane factory has to contend is the nature of Indian land tenure, by which the country is split up into a multiplicity of small holdings, and this seems to be an insuperable one. The effect of this system of cultivation in innumerable small farms is that concentration of crop round the factory is, in most instances, impossible. The cane is grown in small isolated patches, and in order to feed a large factory, cane has to be collected from a very large area radiating many miles from the factory, with all the consequent heavy cost of handling and carrying entailed in dealing with a commodity so heavy and bulky as raw sugar-cane; this combined with the inevitable deterioration and loss of sugar by inversion during the period of transit from the fields to the mill more than counterbalance the benefits gained by the continuous process.

It would seem, therefore, that central cane factories can only be profitably worked, if at all, in Canal Colonies or large zamindaries where a concentrated area is available under the personal control of the owner or planter.

If the sugar industry in India is to hold its own against the foreign importer, development will have to be along the line of intense cultivation by the grower to increase the outturn of sucrose per acre and improvements in the making of raw jaggery or *Gul* by the villager, preventing the heavy losses by inversion and adulteration entailed by the crude methods at present employed. If this can be done, the Indian refiner will have nothing to fear from foreign competition in India, and may even in time be able to export to other markets, if not barred by prohibitive protective duties.

IMPROVEMENTS IN PADDY CULTIVATION ON THE COURT OF WARDS' HOME FARM AT SIVAGIRI, TINNEVELLY DISTRICT, MADRAS.

By J. M. LONSDALE, N.D.A., N.D.D.,

Agricultural Expert, Court of Wards, Madras.

Sivagiri is situated about 12 miles, as the crow flies, north-west of Sankaranakoil and about 6 miles from the foot of the Ghauts. The average rainfall is about 25 inches per annum. The Home Farm consists of 252 acres of wet land under four tanks, besides dry and *peramboke.** The soil under tank irrigation varies in texture from sandy to clayey loam, the sub-soil is clayey and overlies a bed of nodular limestone. Some of the land is very much subject to drought, whilst other portions were originally saline, but have now been much improved. The farm has been under the management of the Court of Wards for a considerable number of years, but it was not until M. R. Ry. Rama Rao became Farm Superintendent about eight years ago, that the operations were begun for introducing improvements in the cultivation of paddy for which this farm has become famous by reason of the success attained.

2.—Lines of Improvement.

The lines upon which improvements have been introduced are briefly reviewed below.

(1). *Ploughing*—The ordinary wooden plough has been almost superseded by an iron plough made on the same principle as the local wooden plough. These iron ploughs are used both for ploughing dry and in puddle, and it is surprising with what

* Common land not liable to assessment is called *peramboke* in the Madras Presidency.

ease the small farm cattle seem to pull them and the ploughmen (when at least they have become accustomed to them) prefer them to the old wooden plough, because three ploughings with this iron plough produce quite as good a tilth as five with the wooden one. The action of this improved plough is to cut the soil into slices or furrows and turn the furrows over face downwards, thus burying the weeds for the sake of which it is necessary to plough so often with the wooden plough. These iron ploughs are made by the village blacksmith from old ships' plates bought from Rajapalayam in the Srivillputtur Taluk. The total cost, without draught and yoke poles, is about Rs. 6, and anyone who wishes to purchase one may order the same from the Farm Superintendent.

(2). *Manuring*—It is well known that paddy is a crop which exhausts the soil, and (if the irrigation water is not heavily ladened with silt) manure of some kind must be put on every year if good crops are to be obtained. Experiments carried out from year to year at Sivagiri show that the best and cheapest manure for paddy is that obtained from the dung, urine and litter of animals, which has been properly preserved whilst rotting, commonly known as farm-yard manure. On this Home Farm all the manure which can be conveniently collected both on the Farm and in the village, is gathered up every day and put into pits and well mixed up with litter and refuse and left until it is sufficiently rotted. Whilst rotting, it is occasionally moistened with water or urine to make it rot more quickly and in order to prevent its becoming too heated. To protect it from the scorching sun, it is kept covered with a layer of tank silt or soil. Because of the immense quantities of cowdung used for fuel, and also because the farm livestock of this country are so poorly fed, the amount of farmyard manure available is by no means sufficient to maintain the fertility of the paddy lands up to an average standard. It is, therefore, absolutely necessary to devise cheap and convenient methods of obtaining other kinds of manures besides farmyard manure, and this branch of investigation has received a great deal of attention at Sivagiri and with great

success, judged by the steady increase in the average returns obtained per acre from year to year. The additional manures which have been tried and can be recommended are :—

(*a*) *Green leaves* from plants which are useless for fodder, such as wild castor, *kolingi* (*Tephrosia purpurea*), etc., which grow in such large quantities on the waste lands. Provided they grow thickly within a short distance from the land to be manured, they form cheap manure, but such manure becomes too expensive if the above conditions do not exist.

(*b*) Castor, *Neem Punnai* (*Calophyllum inophyllum*) and *poonacs* are also good manures and cheap if they have not to be brought from long distances by rail.

(*c*) Undoubtedly, however, the greatest success has been attained by the cultivation of *leguminous* crops on the wet land itself during the dry season and the season in which there are only occasional showers of rain. Leguminous crops are those which do not exhaust the soil of its plant-food ; on the other hand, it is found that they actully *increase* the amount of plant-food in the soil. The leguminous crops which are commonly cultivated in this country are groundnut, horsegram (*Kulthi*), red gram (*Dhol*), cowgram, black gram, Bengal gram, muchai bean, and sann-hemp (*Crotalaria juncea*). There are also many leguminous plants which grow wild in the jungles in great quantities, such as *Kolingi*, *avarai* (*Cassia auriculata*), *Cassias* (*Cassia tora*, *Cassia sophera*, *Cassia tomentosa*), *Poongam* (*Pongamia glabra*), *Vathamadaki* (*Poinciana elata*), *Vagai* (*Albizzia lebbek*, *Albizzia procera*), *Usil* (*Albizzia amara*), *etc.* *Kolingi* and sann-hemp are the two leguminous crops which have been grown as green-manuring crops on the wet lands at Sivagiri.

It will be well to give a short account of the cultivation of *Kolingi* at Sivagiri. The seed is gathered from the waste lands when ripe about the month of July. Coolies are paid one measure of paddy for one measure of thrashed *Kolingi* seed. It is then kept in a dry place and occasionally dried in the sun till *pishanum* (winter) paddy is harvested in February, March or April. As soon as possible after a plot has been harvested, the

land is ploughed once, and if the soil is hard, it is cross-ploughed also. If the soil is so dry and hard as to prevent ploughing immediately after harvest, then every opportunity is taken of ploughing after the showers of rain which usually fall in April and May, but the earlier the land is ploughed and the seed sown, the better will be the germination. Three to five heaped Madras measures are then sown broadcast, and it is covered by ploughing once and cross-ploughing with a light wooden plough. No further cultivation is necessary at this stage. It must not be irrigated. The crop is allowed to grow till August or September when every opportunity should be taken of ploughing once through the crop in the dry state after the showers of rain which usually fall during these months, in order that weeds may be destroyed and the soil aerated. *Kolingi* is deep-rooted, consequently little of it is uprooted by the plough, and the uninjured plants will grow much better, and seeds previously buried too deep or too shallow will germinate. In October irrigation water becomes available, the plots of *Kolingi* are then flooded and ploughed in puddle. If the *Kolingi* is very thick and the plants tall, it is advisable, after flooding but before ploughing, to pull the *Kolingi* up by the roots and spread evenly over the plot. It is then easily trampled in by ploughmen and cattle whilst puddling. Thus, by spending about 6 annas on seed and doing a little extra labour in the dry season when the work on the farm is slack, a saving of 10 to 15 rupees per acre for *poonacs* or jungle leaves can be made and often a great deal of time is saved, and all big *ryots* know how important it is not to be late in the transplanting of paddy. *Kolingi* grows best in light loamy soils. It does not thrive well in stiff clays or land which is water-logged.

(*d*) *Sann-hemp* (*Crotalaria juncea*) is a quick-growing crop, especially suitable for the green-manuring of wet land which has borne a *kar* or summer crop. A crop of sann-hemp, 3 to 7 feet in height, can be obtained in from 4 to 8 weeks. It is a rain-fed crop, but if there is no rain, it may be irrigated with about one inch of water every 10 days. It is largely grown as an

unirrigated second crop after paddy in the Kistna and Godaveri Delta lands. It is a most excellent fodder for cattle if cut when from 5 to 7 weeks old and sown about 20 Madras measures per acre (the capacity of the Madras measure is 62·5 fluid ounces). When cultivated for green manure at Sivagiri, it is sown at the rate of 12 Madras measures per acre in August or September after the land has been ploughed. It is then covered by two light ploughings, and if there is a little moisture in the soil, it germinates in about 3 days. No further cultivation is necessary. Before the plots are flooded in October or November, the sann-hemp is cut and bundled, and the bundles are led on the bunds on each side of the plot. The plot is either ploughed dry or in puddle. Then the sann-hemp is taken and spread evenly over the plot. It is then trampled in. Nothing then remains to be done but levelling the plot and transplanting immediately. A plot of land, about 6 acres in extent, on the Home Farm, which had never been known to give more than 700 Madras measures of paddy per acre, was sown with sann-hemp on the 1st of September 1906; by the 1st of October it was an average height of 3 feet. It was ploughed in when 7 weeks old, and the outturn of paddy from that plot was 1,225 Madras measures per acre. Even if the sann-hemp is cut for fodder, the roots and stubble left behind do undoubtedly make the soil richer in plant food than it was before the crop was sown. When sann-hemp is required for seed, it should be grown on *dry* land; otherwise the sann-hemp raised from that seed will not be able to resist drought so well. When grown for seed, a most excellent fibre is obtained from the straw.

(*e*) Another most excellent manure available in large quantities at Sivagiri is *tank silt*. It is applied alone to saline lands on the Home Farm which have been greatly improved thereby. It is also mixed with the farmyard manure. This silt is dug up from the tank bed and thrown down the outer side of the tank bund at a cost of one anna per cubic yard.

(3). *Irrigation*—The most important factor in the successful cultivation of wet paddy is the possession of a sufficient supply of

irrigation water from the time of transplanting up to the time when ripening is well advanced. It has long been considered by some, however, that the quantity of water said to be necessary to grow a crop of paddy, according to the variety of the paddy and its environment, is far too large. It was with the object of trying to prove the truth of this that experiments have been carried out for the last 3 or 4 years at Sivagiri. The results of the experiments go to show that a grievous waste of water does occur when paddy is irrigated according to the customary method at Sivagiri. Quite as good crops have been obtained in many cases with 30 inches of irrigation water as with 60 inches, provided the former amount is used judiciously. In the case of a five-months crop of paddy transplanted one month after sowing in nursery, it is customary to keep the plots deep in water after the transplanted plants have picked themselves up, in order that weeds may be smothered. It is well known that paddy can have too much water known as *neer-shari* (water-choked crop). If the wet land was ploughed in the dry season or even a month or so before the time for puddling, as nursery beds are, the weeds would already be killed and would not require drowning with water, and much of the water which runs to waste at this time would be saved up in the tank or canal. Even when the weeds are killed, it is customary to still keep the plots deep in water, and it is only a short supply running from the sluice gates which forces a reduced level in the plots : the result is that, if the supply of water fails, paddy grown under these conditions almost immediately succumbs to drought, but it is found that paddy irrigated and then allowed to become almost dry between each application of water, can withstand drought for a longer time. Large areas of paddy have been grown in seasons of scarcity on the Home Farm by not letting irrigation water into the plots until the surface of the soil had just begun to crack.

(4). *Single planting of paddy seedlings*—This is a question which affects most of the South and West of this Presidency and some parts of the North also. When it is considered that

there are about 74 lacs of acres of wet land in the Presidency, the ways and means of reducing the amount of paddy seed used per acre must necessarily be of great importance to most of the ryot class. It has been proved conclusively at Sivagiri that the amount of seed used per acre can be enormously reduced (*without reducing the yield*) by transplanting single seedlings instead of a bunch varying in number from 2 even up to 20. This is because the paddy plant possesses the property of throwing out new shoots when planted *singly*, but which does not occur to any great extent when paddy is planted in bunches. It is difficult at first to teach the coolies to plant singles, but when this has been done, there is a direct saving at least equal to the value of the seed saved, as there is no extra cost for labour. One point, however, until recently, has been overlooked, *i.e.*, the rate per acre at which seed is sown in the seed-bed must be reduced to at least 100 Madras measures per acre in order that the roots of the seedlings shall not be so closely matted together: otherwise, the transplanting coolies cannot separate them easily into single seedlings. The average seed rate on this Home Farm last year was 16 Madras measures per acre or nearly 40 pounds of seed, and it is hoped that it will be possible to still further reduce this quantity to about 8 Madras measures per acre when the coolies become more expert. This characteristic of throwing out new shoots is called 'tillering.' Most varieties of paddy in the South have partially lost their powers of tillering; but it has been observed that these varieties, if they are planted singly year after year, gradually regain the power to tiller.

(5). *Introduction of New Varieties*—A number of excellent varieties of paddy have been introduced from Northern India and elsewhere. The characteristics of these new varieties have been studied, and seeds specially selected and stored for sale to the public. A number of these varieties, *e.g.*, *Swarnavari* and *Banku*, are particularly good, because although they are paddies of fine quality and good yielders, yet they are early-maturing and are good resisters of drought. The reason why they possess these qualities is because these varieties have been grown for a long number of

years in parts of India where the atmosphere is exceedingly hot and dry, and where irrigation water is never very abundant. It is important to remember that such varieties gradually lose these characteristics when they are grown in a locality where the air is damper, and where they receive much more irrigation water than they have been accustomed to. This makes it necessary to get *new seed* every five or six years from the country where the variety originated.

(6). *Seed Selection*—Seed is specially selected every year from the local varieties of paddy which prove most profitable and also from the introduced varieties. This is used as Home Farm seed the following year. Some selected seed is also available for sale to ryots. If a large quantity of selected seed of any particular variety is required, an order should be sent to the Farm Superintendent early, *e.g.*, if it is *pishanum* (winter) paddy, order not later than January ; if it is *kar* (summer) crop, not later than June. The selection is done by picking out the best ears immediately before or after the crop is cut. These are bundled and thrashed separately, and the seed is carefully dried in the sun and stored in large earthenware pots. Special attention is paid to picking out ears which are quite true to the variety and quite free from disease. Care is also taken that all the grains in the ear are fully ripe and close-set. An ear is rejected if many of the grains have already been shed from it and also if the glume or outer skin of the grain is empty. Seed is not usually selected from crops growing on patches of ground which are badly drained, even though the ears thereon are good specimens of their kind, unless it is a variety of paddy which is specially suited for water-logged soils like *Kulavalai* paddy. On the other hand, ears are picked from a crop growing on a plot which has been subjected to drought, even though the ears are not quite so large and good as ears of the same variety growing on a plot which has not been subjected to drought. One of the chief points to be considered in the selection of most varieties of paddy seed is to try and increase the *drought-resisting* power of the variety even though the yielding power is slightly decreased.

(7). *Dry Cultivation of Paddy Lands*—Except on very sandy and very poor soils the dry cultivation of wet lands has been found to have a very good effect. If ploughmen and bullocks can be spared from the work of thrashing, carting the grain and stacking straw, the plots are ploughed immediately the crop is taken off the ground provided the soil is not already too hard. If these cannot be done, the land which is not cultivated with *kar* crop paddy is ploughed whenever there is an opportunity after the occasional showers of rain which fall from the beginning of April to the end of September. The main effects of this dry cultivation are:—

(*a*) More plant-food is rendered available for the succeeding crop.

(*b*) The air gets into the soil which enables the roots of paddy to go down deeper, thus making it less subject to drought and increasing the area from which the plant obtains its food-supply.

(*c*) Weeds are destroyed.

Many ryots ask 'how will the cattle be fed if the wet land is ploughed up during the dry season?' The reply is that more is lost in paddy than is gained in grass, and the shortage in grass must be replaced by the growth of sann-hemp and other valuable fodder crops, which can be grown at a very small cost and preserved in stacks until required.

3.—Varieties of paddy grown at the Home Farm, Sivagiri.

A short account of the different varieties of wet land paddy grown at Sivagiri may prove useful to agriculturists who wish to buy seed from the Home Farm. Brief notes will be given indicating whether—

(*a*) the variety is a *pishanum* or *kar* crop;

(*b*) the average duration of the crop from the time it is sown in the seed-bed to harvest will be given in months;

(*c*) the quality of the grain from the rice merchant's standpoint will be given as 'fine,' 'coarse,' 'medium,' etc.

Manalvari is both a *kar* and *pishanum* crop, four months, coarse-grained, local variety, yielding reddish-coloured rice. Average yield for *kar* crop of 1907 was 944 heaped Madras measures per acre. (A heaped Madras measure is equal to 68·75 fluid ounces.)

Chitraikali is a *kar* crop, three months, coarse-grained, local variety, yielding white rice ; average yield for *kar* crop of 1906 was 875 heaped Madras measures per acre. The rice does not break easily when husked raw.

Halki being a recently introduced variety ; the proper season is not yet known. It is a four-months, fine, scented variety, yielding during the *pishanum* season of 1907 and 1908 at the rate of 918 heaped Madras measures per acre. This variety has long spikes or awns on the ear head.

Banku is a four-months variety, said to have been introduced from Nagpur in the Central Provinces ; fine, long, slender grain, straw of superior quality, tillers well, withstands drought, easily husked, and the rice is gummy, *i.e.*, it contains a good percentage of muscle-producing food. A crop grown in the *pishanum* season of 1905 and 1906 on a plot measuring 5·07 acres yielded at the rate of 1332 heaped Madras measures per acre and 1,600 lbs. of straw per acre. The land was prepared solely with improved ploughs and was manured only with a *kolingi* crop grown on the plot. The seed was sown on October 10th, and transplanting, in single seedlings, one span apart, was begun on the 10th of November, and harvest started on the 9th of February. The grain was sold at 10 to 11 Madras measures per rupee. During the last two months, water being scarce, the surface of the soil was just kept black with moisture.

Badshabhog is a 4-months, introduced, fine, slightly scented variety from North India. The rice is small, and being short, the husk is removed without breaking the grain. Tillers well. In the *pishanum* season of 1906 and 1907 it yielded at the rate of 1,012 heaped Madras measures per acre.

Swarnavari is a three and-a-half months variety, newly introduced from Cuddalore. It may be grown either in the *kar* or

pishanum season. The average yield of the *kar* crop in 1907 was 897 heaped Madras measures per acre and 954 Madras measures during the following *pishanum* season. The rice is white, and the straw is superior in quality, remaining more or less green right up to the time of harvest.

Poombalai is a *pishanum*, five-months, local variety, with grain of medium quality. The average yield during the *pishanum* season of 1907 and 1908 was 997 heaped Madras measures per acre.

Kularalai is a six-months, coarse-grained, *pishanum* crop, suitable for submerged and water-logged land.

Anaikomban is a six-months, fine-grained, *pishanum* variety. It is considered the best quality local variety. The average yield during the *pishanum* season of 1906 and 1907 was 1,150 heaped Madras measures per acre.

4.—The Returns for Paddy Cultivation at Sivagiri for the year ending 30th April 1907.

The average yield of paddy per acre for the *kar* crop which was cultivated only on 127 acres was 890 heaped Madras measures. The corresponding yield for the *pishanum* crop cultivated on 252 acres was 886 Madras measures. If the two crops are added together, it will be seen that each acre of wet land on the Home Farm yielded during the year at the rate of 1,340 Madras measures. Calculating the value of the paddy at Rs. 9 per 100 heaped Madras measures, the value of the paddy produced on the Home Farm during the year was Rs. 30,484. The value of the average yield of each acre, *viz.*, 1,340 Madras measures, was Rs. 120-10. The cost of production was also carefully worked out. As practically the whole of the Home Farm receipts are obtained from paddy, the whole of the working expenses for the year were charged to paddy. The cost of production of 1,340 heaped Madras measures being approximately Rs. 37. The cost of producing 100 Madras measures of paddy was Rs. 2-12. The net profit per acre was Rs. 83-10. This latter figure being obtained by deducting the cost of production per acre from the value of paddy which each acre yielded

during the year. The above figures show that paddy can be made into a very profitable crop even on a farm under public management where the cost of labour is necessarily higher than it would be if the land was farmed by the zemindar or by a ryot.

THE AGRICULTURAL SECTION OF THE NAGPUR EXHIBITION, 1908.

By G. A. GAMMIE, F.L.S.,

Imperial Cotton Specialist;

AND

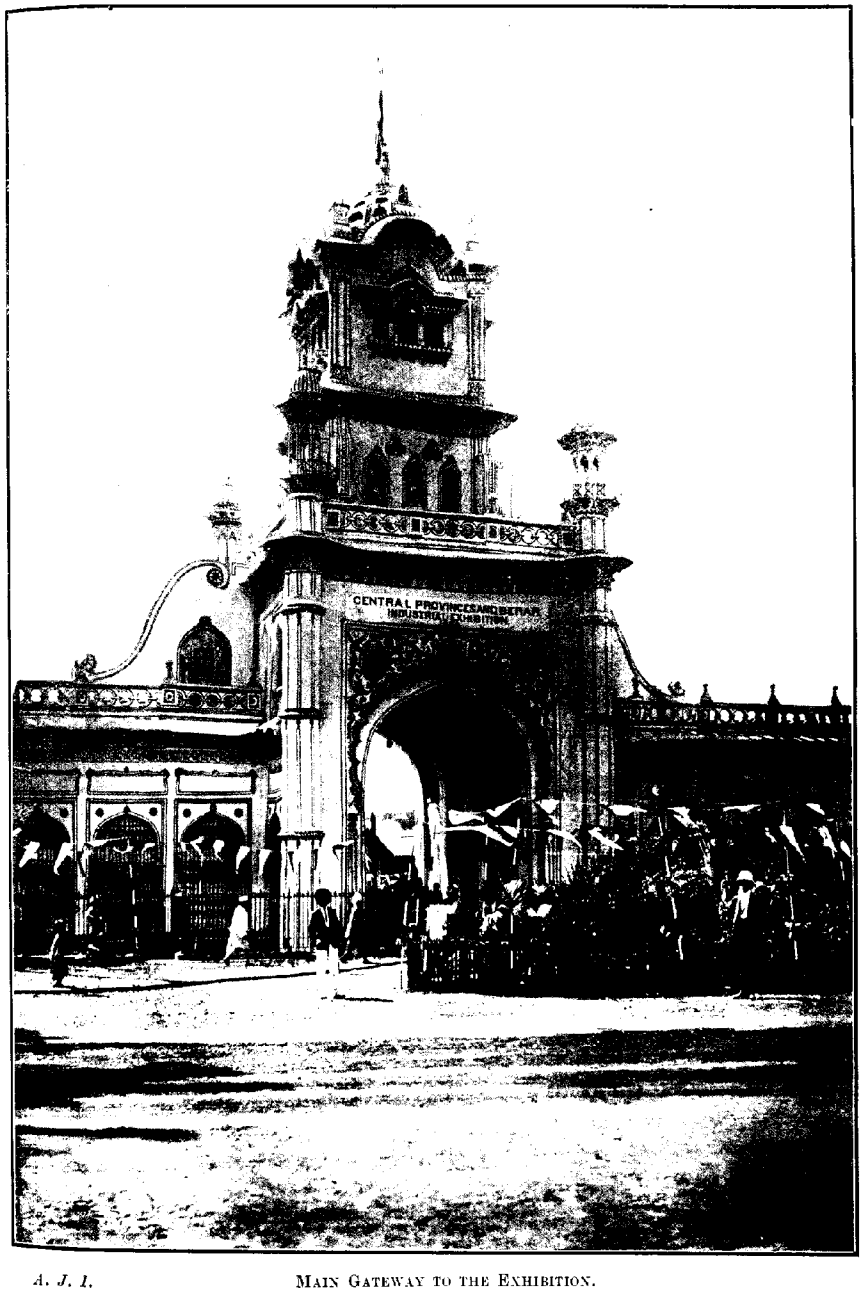
E. SHEARER, M.A., B.Sc.,

Imperial Agriculturist.

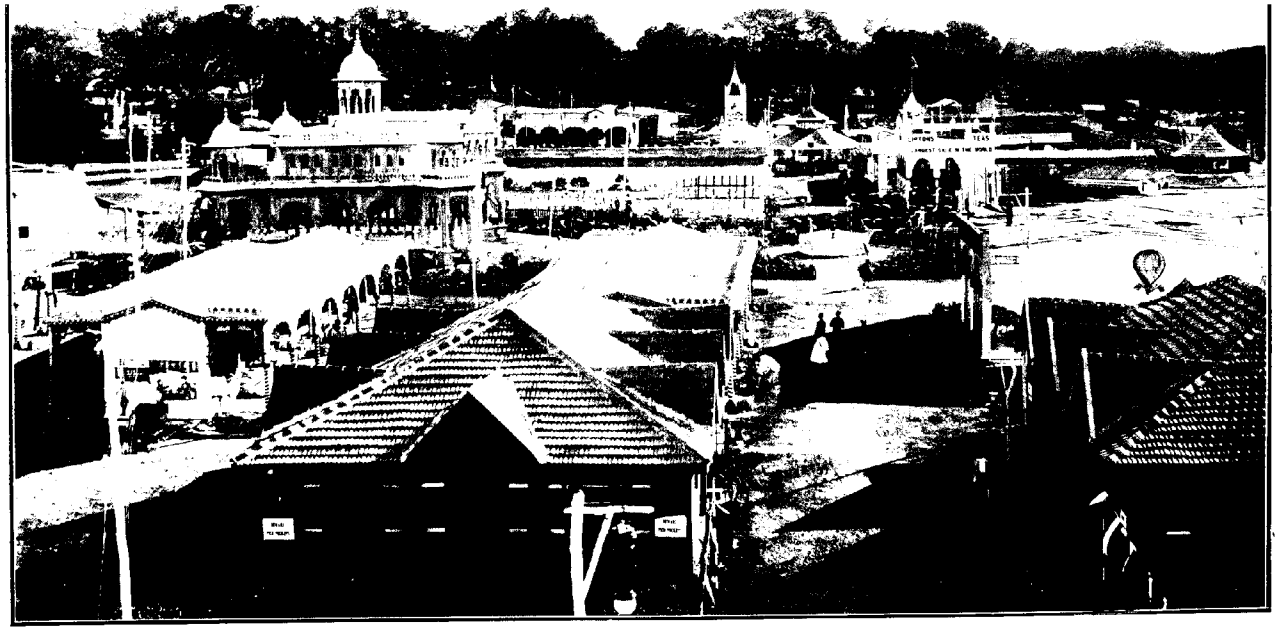
From the admirably arranged official handbook to this exhibition, we learn that the first Nagpur Exhibition was opened on the 26th December 1865, about three years after the establishment of the Central Provinces, as an integral part of the Indian Empire. In 1866 another exhibition was held at Jubbulpore for the instruction of the inhabitants of the northern half of the provinces. This was, of course, in ante-railway days when intercommunication between distant parts was maintained with difficulty. It was the original intention to continue with a series of exhibitions at short intervals, but this idea was never carried into effect, so that the present is but the second Exhibition at Nagpur. During the long interval of forty-three years that has elapsed, an enormous expansion has occurred in the population, trade and material prosperity of the country.

The present exhibition is the outcome of a meeting held on the 2nd December 1907, by a number of influential gentlemen representing all parts of the Central Provinces and Berar, when a large sum was subscribed on the spot, and a strong organising committee was formed. Altogether Rs. 90,000 were received from private sources. Government gave a grant of Rs. 50,000, and Dewan Bahadur Kasturchand Daga generously gave the magnificent sum of Rs. 25,000 to defray the cost of building a fine stone

PLATE XIV.



A. J. I. MAIN GATEWAY TO THE EXHIBITION.



A. J. I. GENERAL VIEW OF THE EXHIBITION.

pavilion of pleasing architecture, which will remain as a permanent memorial of the Nagpur Exhibition of 1908. (Plates XIV & XV.)

Seventy per cent. of the population of the Central Provinces is directly engaged in agriculture, and a considerable proportion of the remainder is, in a large measure, dependent on it. It was fitting, therefore, to find that the agricultural section was one of the largest and most complete in the exhibition. The entrance to the section (Plate XVI) was emphasised by a triumphal arch carefully worked out in detail by Mr. D. Clouston. The decorations were composed of heads and sheaves of the principal crops and paintings illustrating improved methods of cultivation recommended by the Local Agricultural Department. The latter was responsible for the biggest share of the exhibits, but there was also a large number shown by the departments of other provinces, notably that of Bengal, and by private firms and individuals. Taking those of the Central Provinces Department first, we found them grouped into three main classes: (1) soils and manures; (2) crops and their products; and (3) implements.

In the first class were shown samples of the various soils of the provinces, and a collection of natural and artificial manures. Some of the soils were divided up to show the relative proportions of the important constituents, and the water-absorbing capacity of various soils was demonstrated. There were also pot cultures of field crops, such as rice and cotton, illustrating the effect of variety and manurial treatment.

Coming next to the crop section, we found very full collections of rices, jowars and wheats, accompanied by chart, showing graphically the results obtained by different methods of cultivation; sugarcane, a crop which is being fostered by the department, was represented by excellent samples of Red, Green, Ashy and Striped Mauritius, Gilman's Red Sport and Pundia. The exhibits of cotton, a crop of major importance on which the prosperity of the provinces largely depends, were specially interesting. The map which accompanied the exhibits showed that with the exception of a small strip abutting on the Nizam's dominions where "Bani," a superior race, is grown, the bulk of the cotton

is derived from a coarse but prolific variety known as "Jari." Research has disclosed the fact that this is not a pure crop, and that in the mixture a better form does exist, and steps are being taken to encourage the cultivation of the latter. The Upland Georgean is not very promising, but the "Bhuri Kapas" introduced from Singbhum in Bengal gives much promise. The exhibits of maize, bajra, millets, pulses, oilseeds and oilseed residues, fibres, fodders and garden crops, call for no special remark.

The implement and machinery section (Plate XVII) attracted much attention from visitors, and deservedly so. On a convenient open space of ground the department had arranged a collection of improved ploughs, drills, chaff-cutters, thrashers, winnowers, chain pumps, cotton gins, sugarcane mills, hay presses, flour mills, maize shellers, etc., and also a complete installation to demonstrate the Hadi process of sugar manufacture. Each day from 3 P.M. to sunset all these implements and machines were worked under the close personal direction of Mr. Clouston and a staff of assistants. With the co-operation of the District Agricultural Associations, selected batches of cultivators from all parts of the provinces were brought in on fixed dates, taken charge of by assistants of the Agricultural Department and shown over the exhibition and the Nagpur and Telinkheri Farms. Lectures were also delivered describing the agricultural improvements recommended by the department. Numerous orders for certain of the implements and machines shown, were booked on the spot, but apart from this the educational value of the demonstrations must have been of a very high order.

The Turnwrest ploughs, which for some time past the department has recommended for breaking up black cotton soil in the hot season and for the eradication of Kans, command a steady sale. The department showed a more recent type of plough obtained from Messrs. Ransome, which they believe to be an improvement on the Turnwrest for heavy work in black cotton soil. The Harder winnower sold by the department at Rs. 123 was doing good work and seemed well adapted to the conditions of the provinces. Two threshers, Mayfarth's and Harder's, were

PLATE XVI.

A. J. I. ENTRANCE GATEWAY TO AGRICULTURAL SECTION.

PLATE XVII.

A. J. I. AGRICULTURAL MACHINERY AT WORK.

shown. These worked fairly well, but there is little demand for this sort of machine at present. Amongst fodder-cutters Harder's No. 10 is recommended by the department.

Of the water-lifting appliances the chain pumps attracted most attention. The hand pump (cost Rs. 55) worked by two men is said to raise 1,600 gallons per hour to a height of 12 feet. The double chain pump (cost Rs. 110) worked by a pair of bullocks and bullock gear (cost Rs. 102) will raise 6,000 gallons per hour to a height of 20 feet. It seems to us that, where the lift is not beyond this, oil engines, with their big initial outlay, cost of running and heavy depreciation in unskilled hands, will find it difficult to compete with such an economical form of water-lift.

In addition to their own exhibits in this section the department tested those sent in by firms and individuals. A three-roller iron sugarcane mill (Plate XIX) from the Nahan Foundry, Punjab, struck us as being the best mill of the kind which we had seen. The workmanship is good, and the cost (Rs. 110 with rollers $8\frac{1}{2}'' \times 8\frac{1}{2}''$) is moderate. A good flour mill (Plate XIX) worked by a pair of bullocks (cost Rs. 150) was shown from the same foundry.

Messrs. Burn & Co. had a good show of power machinery, including engines, pumps, rice huskers and a large agave decorticating machine suitable for plantation work. They were awarded a Gold Medal for their exhibits as were also Messrs. Marshall, Sons & Co. for a similar series.

Mr. Winsor, of Sirur, in the Poona district, exhibited two small fibre machines suitable for agaves or plantains. One, the Daw decorticating machine, requiring one man to operate it, and said to produce an average of 25 lbs. of fibre a day, is sold for Rs. 75. The other, the saw fibre machine, is sold in three types, a hand machine for Rs. 125, a double machine for power at Rs 500, and a quadruple machine for power at Rs. 750. The last run by a two-horse-power gear is said to yield 250 to 500 lbs. of fibre per day of ten hours, or from 30 to 125 lbs. per day for each wheel. It requires four men to feed the machine, besides those engaged in bringing leaves, etc. These two machines are worth testing by owners of small plantations.

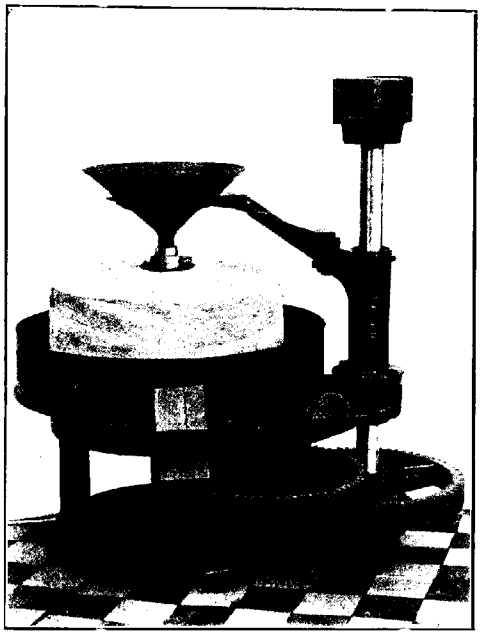
Several modifications of country ploughs, drills and hoes, were shown by cultivating natives of the Central Provinces. These are worthy of remark, not so much on account of their individual merits, though in one case, where to the ordinary drill an attachment for covering the seed had been added, the idea was good and worked satisfactorily, but as showing that, as a result of the work of the Agricultural Department, the people are realising that their old methods are capable of improvement and are themselves doing something towards this improvement.

Of the exhibits sent in by the various provinces only the collection shown by the Bengal Agricultural Department calls for special remark. This was particularly complete and well arranged and reflects great credit on Mr. Woodhouse, who, we understand, was responsible for getting it together. The sets of ordinarily grown cereals, pulses and other field and garden crops were probably complete. As a result of the experimental work of the Bengal Department, they are able to recommend certain varieties, such as Saran jowar, Jaunpur maize, Dumraon oats, Saran rahar, Patna gram, Cuttack groundnut, Raipur and Jubbulpore mustard, Kakya, Bombai, Hewti and Deswal jutes and Naini Tal potatoes. Seeds of these can be obtained on purchase from the department's godown. There was a complete set of jute fibres (including some specially good samples sent in by Mr. Finlow), a large variety of materials used in tanning and dyeing, and a good collection of grasses and seeds used in basket-work and mat-making, paper and rope manufacture. Of the cottons shown, *Buri*, an acclimatised form of Upland Georgean grown in Singhbhum, was the best. The famous Dacca muslin was probably made from the *Jaria* of Bengal. (Plate XVIII.)

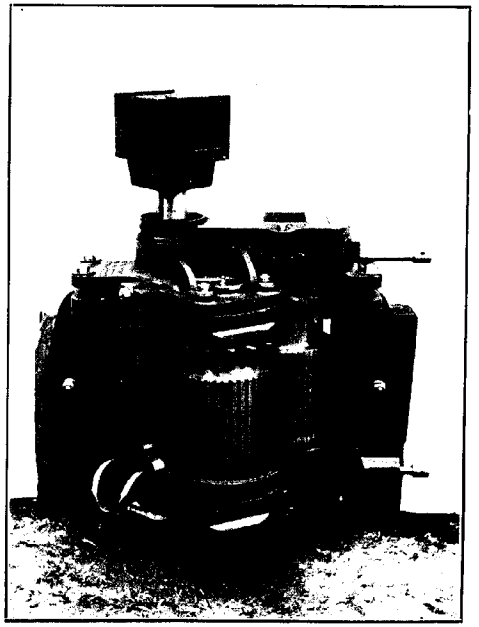
What materially added to the value of the Bengal exhibits was an excellently prepared series of maps and diagrams clearly illustrating the rainfall and the distribution of the principal crops throughout the province, the results of manurial trials and of experiments in spacing in transplanted rice. The Bengal Fishery Department showed, in a glass aquarium, several kinds of tank fish which are said to breed and grow rapidly in tanks and

A. J. I. BENGAL CROP EXHIBITS IN AGRICULTURAL SECTION.

PLATE XIX.



A. J. I. FLOUR MILL.—NAHAN FOUNDRY.



SUGAR MILL.—NAHAN FOUNDRY.

marshes and to be nourishing as food. In the sericultural branch, besides examples of silk cocoons, there was a silk-reeling machine from Berhampore, shown in operation by an ordinary villager, assisted by a small boy, a silk loom from Murshidabad and samples of silk in all its stages.

For the special agricultural week in the middle of December there had been arranged a Cattle Show and Bullock Races. The Cattle Show was distinctly disappointing. The prizes offered, though large and numerous, attracted few entries, and these were certainly not representative of the best types of cattle to be found in the Central Provinces; as a matter of fact, most of the entries came from the immediate neighbourhood of Nagpur where the cattle are not very good. The well-known Malvi breed was not represented at all, while only one pair of Berari cattle was shown. The bullock races, on the other hand, were very successful. The keenness of the natives of the Central Provinces on this form of sport is shown by the fact that, for one of a pair of bullocks that competed, his owner had given Rs. 600. This high figure was justified by his success in the races.

In concluding this brief and imperfect account we would congratulate the Central Provinces Agricultural Department on an Agricultural Exhibition which was probably the most successful ever held in India, and which might well serve as a model for similar exhibitions in other provinces. It is not too much to say that this result was due mainly to the efforts of Mr. Clouston who was indefatigable in organising the exhibition and in making it a success after it had been opened.

Readers who are interested in the other sections of the exhibition will find much useful information in the Official Handbook.

PUNJAB GARDEN HEDGES.

By W. ROBERTSON BROWN, F.R.H.S.,

Superintendent, Agri-Horticultural Gardens, Lahore.

In some of the more important stations of the Punjab, hedges meet the eye in every direction. The Mall and some of the less important roads have hedgerows: in many bungalow-gardens, there is quite a maze of hedging.

These hedges are generally fairly shapely, yet ragged and unsightly examples are not infrequent.

There has been a tendency during the past few years to plant too freely, and the charm which bright trim hedging lends has been somewhat detracted from by injudicious use. Just as the *mali* crowds as many purposeless little paths into the garden as he possibly can, so he is inclined to introduce a hedge wherever a hedge is possible. Much valuable time which might, with advantage, be devoted to the eradication of weeds from the lawns or to other necessary work, is frittered away in the maintenance of unnecessary hedges and paths.

Invariably, hedgerows disappear with the outlying bungalow of each station; living hedges are not favoured by the agriculturist, and when it is remembered that these afford excellent breeding ground to rats and other ground vermin, he is probably right in his avoidance of the possible evil.

I will discuss chiefly those plants which are popularly used with the object of gaining firm, unbroken hedgerows. The rose and the Bougainvillœa can hardly be classed as true hedgerow plants. These are straggling in habit; they have not stiffness; they are liable to be "gappy." Lime, Dodonœa and Duranta, on the contrary, are examples of the most amenable hedgerow subjects.

For ornamental work our ideal hedge plant should be—

(1) Perfectly hardy.
(2) Capable of rapid and easy propagation.
(3) Fibrous rooted and therefore easy of transplantation.
(4) Evergreen.
(5) Compact in habit.
(6) Rapid in growth.
(7) Drought-resistant.
(8) Responsive to trimming, and
(9) Sufficiently soft in growth to permit of easy cutting by hedge-shears.

I have not observed any plant which positively has all the qualities enumerated above. The popular Lime, Duranta or Dodonœa most nearly approach the ideal. "Jait" (*Sesbania*), Bougainvillœa, *Acacia farnesiana*, are not so good, though each excels in some way for special purposes.

I will briefly consider the more important of the above mentioned.

Duranta plumieri with blue flowers and its white variety are together the most popular hedge plants in the Punjab. Though browned a little during the cold days of January, they are yet evergreen and thoroughly hardy over the greater part of the Province. Cuttings planted in March, in a sheltered nursery, root almost as readily as willows and are fit for transplanting to their permanent quarters by the following August. Seeds germinate freely in spring, but the growth of seedlings is comparatively slow. Being fast in growth, the shoots soft and easily trimmed, and the plant branching freely, a compact, firm hedge can be quickly formed.

But the Duranta is only a moderate drought resistant : the burning days of May and June leave the hedgerow limp and dusty. On the other hand, the plants revive with remarkable rapidity after rain or irrigation.

The foliage of the Duranta is somewhat rough and retains dust. On this account, the plant is not suitable for planting by much trafficked public roads. Nor is a solid firm hedge of over

four feet in height readily formed by Duranta. Lime is then more stable and satisfactory. When a free untrimmed hedge is desired, the Duranta can hardly be excelled. Both the blue and the white, but more especially the white, varieties make exquisite pictures when drooping in their lavish profusion of charming blossoms and orange-coloured berries. Then the dainty sprays, so suitable for vases, can be gathered during quite eight months of the year.

Though the white is only a variety of the blue *Duranta plumieri*, the former differs most decidedly from the species in several important points. The white variety has deeper green and tougher foliage, a more compact habit, and it is less readily affected by drought. For hedges of $2\frac{1}{2}$ feet and under, the white variety is the better plant.

Dodonæa viscosa—The "Sanatta" or "Aliar" almost rivals the Duranta in public favour. It also is scorched just a little during the more severe days of January in some years. But it is hardy, thoroughly hardy, in any part of the Punjab plains.

In a plant so very easily and quickly raised from seeds, there is no necessity for propagating by cuttings. If seeds are sown broadcast, in the poorest of soil, in February or March, the plantlets will be fit to transplant, 9 to 12 inches apart in their hedge-row lines by August. If planting has been done with care, a beautiful compact bright green hedge of 2 to 3 feet in height should result by the 15th October of the same year. Within 18 months from the date of seed sowing, a well-managed Dodonœa hedge should be 3 or 4 feet in height, solid, trim, of a beautiful shining green and quite as fine as the best 5-year old "Privet" hedge in England. Surely, this is rapid enough for the most impatient of gardeners.

Dodonœa seeds are frequently sown where the hedge is desired. This method is not generally satisfactory; a close, uniform hedge is rarely obtained by this method. Besides, growth is much more rapid when the plants have been transplanted.

Setting out plants which are over 6 months of age is another frequent cause of disappointment, as the Dodonœa is impatient of disturbance when over the above age.

Nor does the Dodonœa carry well by rail, however carefully packed, for plants should be in position within 2 or 3 hours of their actual lifting. Duranta or Lime plants may hang their heads after transplanting for a few days ; yet all may be well. Not so with the Dodonœa. If two days after planting, any plant curls its foliage, replace it—it will die. The Duranta is fibrous-rooted ; the Dodonœa is tap-rooted. It will be understood, therefore, why the Dodonœa must not be transplanted after it is six months old ; its tap root will have rooted deeply, and in lifting, this would be severed.

The Dodonœa is at home on the arid slopes of the Sivaliks and of the Salt range, and, as is to be expected, is an admirable drought-resistant. In a good sandy loam with sparing irrigation, it is luxuriant. In a wet sour soil, the Dodonœa simply will not grow.

As to trimming, no hedge plant is more easily clipped. The *mali* delights in trimming Dodonœa. A word of warning is necessary, however. If trimming is neglected for even three months between April and October, the hedge may be irreparably spoiled. A Dodonœa hedge may be maintained practically at 3 or 4 feet in height for five or more years, but it cannot be headed back. Lime or Duranta, on the other hand, springs with renewed vigour when severely pruned.

Thus far only the praises of Dodonœa have been sounded. Now we come to some grave defects. Our subject lacks firmness and stability ; a child may brush through the finest and most compact Dodonœa hedge. Happily, however, displaced twigs and branchlets as readily assume their former positions. Next, and this is a most serious fault, many Dodonœa plants die during an exceptionally wet monsoon such as we last year experienced. In normal seasons, however, the plants are not injuriously affected. Duranta and Dodonœa plants cost from Rs. 4 to Rs. 6 per hundred.

Citrus medica—In the "Lime," we have a hedge subject totally different from the Duranta and Dodonœa.

In considering the Lime, it must be borne in mind that there are two distinct varieties which are commonly planted. The best, and that which is most frequently used for high, bold hedges, is known as the "Khatta Nimbu" or large sour lime. This variety has much broader foliage, and more lusty growth than the small sour lime or "Khatti Nimbu." The latter is used for hedges which are under five feet in height. Both varieties are perfectly hardy, even well up on the hills, both are evergreen, fairly rapid in growth, and form handsome impregnable hedgerows when well-grown.

Limes may be planted in the form of hedgerows until they are six years of age and quite five or six feet in height, provided the plants have been transplanted two or three times during that period.

The plants are raised from seeds, and these germinate most freely when sown broadcast in late November or December, in sheltered and well-prepared nursery beds, or in 8-inches pots. Lime seeds soon lose their vitality and must be sown immediately they are extracted from the fruits.

The seedlings are not generally large enough to transplant to the nursery lines within less than six months from the sowing date, and during the rains is the best time to perform the work. Sturdy plants, of about 18 inches in height, should be ready for their transfer to the hedgerows within 18 months or 2 years from the date of seed sowing.

It will thus be seen that the amateur gardener will save much time by purchasing nice plants either in early August or late February. The cost of plants is about Rs. 10 per hundred, and is, therefore, double that of Duranta or Dodonœa.

Probably because of the rather high price of plants, limes are frequently planted at over wide intervals. This is to be regretted. When more than 18 inches are allowed between the plants, a well-furnished hedge is not readily made unless very hard cutting-back is carried out during the first two years of growth

The shoots of the lime are somewhat tough and certainly are not so easily cut as those of Duranta and Dodonœa. Trimmed at the proper time, however, cutting is not at all difficult.

I have known the roots of a lime hedge to be submerged in water for ten days, and apparently without any after-ill-effects to the plants. On the other hand, I have observed a lime hedge to appear to be utterly dried up in May and June; yet in mid-August and during the rains, the same was lush, green and happy.

It is unfortunate that the lime cannot be more rapidly propagated, and that the cost of the plant must always be rather high on that account. Rs. 10 per hundred plants with heavy freight charges added, make hedge planting decidedly costly.

The *mali* complains that lime hedge cutting is hard work, but his complaint is true only when trimming has been unduly delayed, and the growths have toughened. Under the care of sturdy workmen I believe that the lime would prove almost the equal of the justly lauded holly or yew of England in all-round excellence as a hedge plant.

The Duranta, the Dodonœa and the Lime, I believe, exhaust the list of really efficient and popular Punjab Garden Hedgerow subjects. Others there are which are superior under special circumstances. *Sesbania ægyptiaca*, the "Jait" of the *mali*, for instance, is unequalled by any hedging plant in rapidity of growth. Seeds sown *in situ* in early March will give a dense hedge of from 6 to 10 feet in height by the following October. The foliage too is pleasing; it is almost an ever-green; the habit of the plant is erect and compact, and altogether, by the end of the first season, the "hedge-at-once" problem would appear to be solved. In the second year, however, and especially after trimming, a "Jait" hedge presents a somewhat bare and rather sorry appearance, and it will not then compare with the slower growing Dodonœa. With each succeeding year "Jait" becomes more unsatisfactory, but as a rapid growing temporary screen "Jait" is not excelled.

Acacia farnesiana, the "Vilayati Kikar," is not a true garden hedge plant, being over-rampant in growth and more

suitable for the forming of big boundary hedges. In the more Northern parts of the Punjab, where this "Kikar" is very popular, the erect rampant shoots are not entirely removed when trimming is done, but are cut half through at a uniform height and horizontally heeled over throughout the length of the hedgerow. In this way, a dense thorny impregnable fence is soon formed. The small globose fragrant orange yellow blossoms are profusely borne in late Autumn.

Plantlets may be transplanted from nursery beds at 2 feet apart in the line of fence, or seeds may be sown *in situ* and duly thinned as the plants gain in size. Hedges are frequently desired for the crests of banks or by roads or paths which are considerably above irrigation level. For such position, the scandent or trailing *Clerodendron inerme* is superior to Dodonœa, Duranta or Lime.

This *Clerodendron* is rampantly vigorous: the foliage is of a deep glossy pleasing green; the plant is even more drought-resistant than Dodonœa; and trimming is most easy.

Set the plants out at 4 feet apart in March: run a stout wire as rail at about two feet above the line of the plants: lightly trail the growths as they develop over the strained wire or the rail; trim that face of the hedge which is towards the road; and let the shoots freely ramble over the bank behind.

In the course of one season, a *Clerodendron* hedge so treated should present a perfect smooth face of 2 feet in height on the desired side, whilst the dry bank or unsightly channel behind would be effectually screened with the trailing shoots of deepest green. Propagation is readily effected by cuttings during February and March. Plants cost Rs. 12 per hundred, and if these are set out at intervals of 4 feet, it will be found that the *Clerodendron* is one of the very cheapest hedging subjects for positions such as I have mentioned.

Where space is not restricted, the handsome Bougainvillœa forms a very beautiful free boundary or screen. It is ever-green: it glows with bright colour during the cold season; it is perfectly hardy in any part of the Punjab; it is almost grossly vigorous,

and when established, it is independent of any artificial irrigation whatever.

Though trimming presents no difficulties, it must be carried out with discretion. It is necessary to thin the growths ; not merely to shorten these.

The Bougainvillœa is not so easily propagated as most hedging subjects. Stout cuttings are generally procurable, and these, if inserted at about 6 × 12 inches apart in sheltered nursery quarters during March or August, should give a very fair percentage of plants fit for setting out twelve months later.

Some roses, certain climbers, a few shrubs such as *Lawsonia alba*, "Mehndi," *Nerium oleander*, etc., are occasionally used with fine effect as fence plants, but these do not form true hedgerows and will not be considered now.

I will conclude by a few comments on the planting and care of hedges.

It is the custom of the Punjab *mali* to dig a small pit or hole for each plant to be set out in the hedgerow. This method is the worst possible. On no account permit the *mali* to have his way in this, but insist that he takes out a good clean trench at least 18 inches wide by 2 feet in depth. It is impossible to correctly space big and little plants when pits are made : it is too much to expect plants to grow freely into unbroken soil.

If it can be allowed, let the trench remain open for a week and in the meantime, mix some mellow manure with the soil thrown out from the trench. A Lime hedge specially appreciates enriched soil.

After filling in the soil in order to bring the plants to be planted to the required level, twelve or more plants should be set out in the trench at the required distance apart and simply steadied by a little soil. When it is seen that all the plants are straight, and that big and little duly alternate, rapidly fill in the soil, taking great care that this is firmly, yet gently, rammed around each plant. No plant should have more than one inch of soil over its nursery soil line.

The filling in of gaps in an established hedge is difficult and is seldom successfully accomplished. The more forward neighbours of any plants inserted monopolise the soil moisture and nutriment, and the young plants gradually succumb if not specially nourished. If the eriginal work of planting is thoroughly carried out, there should be few failures in the hedgerow.

For irrigational purposes, a depression of not more than 3 inches in the line of the hedge is ample.

Hedging is frequently planted in deep ditches which are at the same time utilised as the channels for the irrigation of the other parts of the garden. So far as possible, this should be avoided as harmful to the hedges.

On the completion of planting, give the hedge a most thorough "flooding home," and this may be repeated a week later.

Not till the hedge plants have been established some three months, and growth has vigorously started, should any pruning be done; and this at first should be confined to lightly shortening the rampant shoots. All that is at first necessary is to preserve a balance of growth in the plants. A Duranta hedge planted in February would require its first real trimming into shape in early August. Later, the trimming must be regularly attended to as often as the top growths gain a length of six inches.

A Lime hedge requires much more severe cutting for its first real shaping in August. The object is to ensure a sound foundation of stout branches. A Lime hedge should be brought on slowly for two years. In the bare open bases of many Lime hedges, there is evidence of undue initial haste.

The Dodonœa merely requires the removal of a few straggling shoots during its first few months of growth, after which regular clipping may be taken in hand.

Undoubtedly trimming to the wedge shape produces the finest hedge. This method is not generally adopted by the *malis*. The square clipped form is favoured. The *mali* finds it so much easier trimming below than on top. He clips more and more beneath and more and more neglects the upper part, until the hedge reels with its top weight and becomes unshapely.

Most fortunately insect pests have thus far not seriously troubled hedge plants in the Punjab.

But there is one dread parasitic plant which is a host of evil in itself, and which is ruining countless hedgerows and trees throughout the Punjab—the insidious *Cuscuta reflexa*. This parasitic convolvulaceous climber stealthily spreads its web of orange yellow threads with marvellous rapidity throughout the body of any hedgerow on which it may have gained its foothold and sucks and strangles its victims to death in a very short time. The first sight of it on the hedge of the keen gardener fills him with despair. He knows he has months—perhaps years—of patient watching and removal of the "threads" by hand to do if he is to conquer the almost irrepressible foe. There are no remedial measures other than the persistent removal of each thread when seen. Where the parasite has permeated the body of a hedge, there is absolutely no hope of eradication. The hedge must be cut to within six inches of the ground; the surface soil removed from beneath the plants; and fresh young growths taken up. Even with such drastic treatment, the hedge must be most carefully watched during the succeeding 12 months.

This *Cuscuta* is reproduced by seeds which may germinate either directly on the host plant, or on vegetable soil beneath the host. The yellow thread-like growths can also reattach themselves to any suitable host. It will, therefore, be seen how necessary it is to be most thorough in any repressive measures. Every twig of any hedge cut down and even the soil from beneath such a hedge should be burnt.

Good roads, smooth green lawns with some nice specimen trees and shrubs, form the most constantly pleasing features in the gardens of the more Northern Provinces of India. Well-chosen, bright, trimmed, and suitably placed hedges can be grown with facility and lend the further charm of privacy and completeness.

OIL ENGINE AND PUMP IN THE TELINKHERI GARDENS AT NAGPUR.

SOME CRITICISMS.

In the last October number of the *Agricultural Journal of India* a note on the working of the oil engine and pump in the Telinkheri Gardens at Nagpur was published. The information was supplied by the Director of Agriculture, Central Provinces. The note has attracted some attention, and Mr. Alfred Chatterton, Director of Industries, Madras, has sent us the following remarks :—

"In the October number of your Journal is a note on an oil engine and pump in the Telinkheri Gardens at Nagpur at the end of which the remark occurs: 'Still it should be stated that oil engines can only be economically used where the supply of water is sufficient to keep them working for 10 hours a day.' I do not know whether that statement is a deduction from the results obtained in the Telinkheri Gardens, or whether it is based on additional independent data. In any case I do not think it should be allowed to pass without comment, as it is very far from the truth, when the engines and pumps are put down by an Engineer and are properly suited to the work that is to be done. In the Madras Presidency there are over 150 oil engines and pumps now at work, and many of these do not work more than six hours a day, and yet they yield highly satisfactory results, and with oil engines and pumps which get 10 hours' full work a day the cost of lifting the water is just one-fourth of what it is with a mhote.

2. "The oil engine and pump in the Telinkheri Gardens are an example of bad work, and the data afforded only serve to demonstrate that fact. Taking the data given in the note, 6,480

gallons per hour were raised to a height of 19 feet, which is equivalent to 0·623 horse-power in the water delivered : that is to say, the efficiency of the engine and pump was 12·46 per cent. I should be glad to supply data of an almost similar installation in which a $3\frac{1}{2}$ h.-p. engine drives a 3″ pump and delivers 13,000 gallons of water per hour to a height of over 25 feet, with an efficiency of nearly 50 per cent.

3. "The Telinkheri installation is defective in the following respects : A 2″ centrifugal pump is a very inefficient motor and should never be used for irrigation work. The smallest size of centrifugal pump which can be suitably employed is a 3″ pump delivering about 11,000 gallons of water per hour. Not only is the 2″ pump too small for the work, but it is obviously being overdriven. The average discharge is stated to be 6,480 gallons per hour, which is at least 33 per cent. more than the pump is designed for, as the velocity of water through suction pipes is 16 feet a second, and the frictional head against which it must work is, therefore, very considerable. If the speed of the pump were reduced so that the pump delivered about 4,500 gallons per hour, a 2 or $2\frac{1}{2}$ h.-p. engine would easily drive it, but it would be much cheaper to substitute a 3″ pump which, driven at its proper speed, could be easily worked with a 5 h.-p. engine running for about two hours in the morning and one and-a-half hours in the afternoon. This, of course, in this particular instance, would not affect the cost of working very much, as it would only mean that the cost of the kerosine oil would be less. That, however, would decrease by Rs. 1-4-0 a day, and the number of gallons lifted for one anna would be 733 or slightly more than the figures given for the mhote. It would thus appear that with the small supply of water available and using kerosine oil, an engine and pump could be made to do the work as cheaply in the Telinkheri Gardens as if it were done by a mhote.

4. "I should like to raise a mild protest against the comparison of daily expenses in a case like this, as the period is too short, and it would be fairer to take the annual working expenses. If an engine and pump are not at work, the interest charges

alone have to be met, as the driver can probably be employed on the other work. During wet weather when the mhote is not required, the cattle have to be fed. Moreover, cattle, working a mhote, require at intervals a day's rest, or they get out of condition.

5. "The deduction I should like to draw from your note on this installation is that it represents the extreme case in which pumps can be employed. The determining factor as to the economy of employing oil engines and pumps for lifting water is not the number of hours per day during which they work, but the quantity of water which has to be lifted, and this, from experience in the Madras Presidency, I put at about 40,000 gallons per day, which means that an engine and pump will then get between three and four hours' work. With double that supply, or seven hours' work a day, the economy is very considerable.

6. "During 1908, in the Madras Presidency, the Department of Industries has erected about 60 installations of oil engines and pumps for private owners, and a considerable staff of Upper Subordinates has been employed in investigating schemes. We never put down a centrifugal pump with a suction pipe of less than 3" diameter, and we never advise the purchaser of an engine and pump to instal a plant unless there is a certain water-supply for the greater part of the year, of 60,000 gallons per day. From experience we know fairly accurately the power taken by any size of pump on a given lift, and to that we add 33 per cent. to determine the nominal brake horse-power of the engine to be purchased. I say nominal brake horse-power as few oil engines and pumps will develop the brake horse-power they are rated at by the makers without giving trouble and requiring frequent repair. Where the lift varies greatly, we provide two pulleys on the pump, so that its speed may be changed when necessary and overdriving prevented. Guided by these simple rules, irrigation with oil engines and pumps is rapidly spreading and will ultimately become an important factor in the agricultural development of India. It is desirable, therefore, that

accurate information regarding its possibilities should alone be disseminated."

The Executive Engineer of Raipur has also made the following remarks on the same note :—

"I have read with interest your article in the October issue of the Journal on the results of pumping with a centrifugal pump driven by an oil engine at Telinkheri Gardens at Nagpur.

"May I be permitted to challenge your statement that an oil engine and centrifugal pump cannot be economically used unless pumping is required to be done for 10 hours a day ?

"Perhaps, my own experience may be of interest to your readers. I have worked in my compound for garden irrigation, a Ruston and Proctor 6 B.H.P. Oil Engine, driving a Mark 3 Ruston and Proctor Centrifugal Pump. The pump has a 4" suction pipe and 3" delivery, and the present lift is 19', the same as that of the pump at Telinkheri.

"The plant is guaranteed to deliver 200 gallons per minute against a total lift of 35'.

"By actual test I find the pump delivers on the present lift 200 gallons per minute with a consumption of oil, per hour, of 0·467 gallons.

"The oil used is Standard Oil Co.'s 125 test kerosine oil, costing Rs. 2-3 per 4 gallons at Raipur, including cost of the tin. The cost of oil per hour is, therefore, annas four.

"At 200 gallons per minute it would take the pump 3·24 hours to raise the 38,880 gallons which the Telinkheri plant raises in six hours. The kerosine oil consumed in doing this work would cost As. 13-3.

"Besides the oil used in the engine, three-eighths pint of 150 test Tide-Water Oil Co.'s Snow flake Oil is required for the starting lamp each time the engine is started.

"This oil costs Rs. 3 per 4 gallons.

"To start the engine twice daily would, therefore, cost As. 1-3. The plant cost Rs. 2,000 landed at Raipur.

"Taking the cost of lubricating oil, wages of Engineer and coolie, the same as at Nagpur, the total cost of running the

engine and pump to raise 38,880 gallons daily, starting and stopping twice in each day would be—

	Rs.	A.	P.
Kerosine oil for engine	0	13	3
Kerosine oil for starting lamp	0	1	3
Wages of Engineer	0	8	0
Wages of Cooly	0	4	0
Lubricating oil	0	4	0
	1	14	6
Depreciation on Rs. 2,000 @ 10% per annum ...	0	8	9
Interest on Rs. 2,000 @ 4% per annum ...	0	3	6
	2	10	9

which gives an output of 909 gallons per anna as against the 720 per anna when bullocks and mhote are used.

"It is evident, therefore, from these figures that even when so small a quantity of water has to be raised, an oil engine and centrifugal pump will do it cheaper than a mhote and bullocks. I do not know why the experiment has resulted so badly at Nagpur; possibly the small size of the pump has something to do with it; but even so, it would appear that a mistake has crept into the calculation of the oil consumption."

Copies of the above two letters were sent to the Director of Agriculture, Central Provinces. He gives the following note by Mr. D. Clouston, Deputy Director of Agriculture:—

"The note in the *Agricultural Journal* on the working of the oil engine and pump at Telinkheri was taken from a report which was asked for by the Inspector-General of Agriculture. The report is an accurate statement of the results obtained in working this particular installation under an officer of the Public Works Department. In the report it is clearly stated (1) that the engine was too strong for the pump and that there was, therefore, a waste of power, (2) that the cost of working could be reduced by using liquid fuel instead of the more expensive kerosine, and (3) by dispensing with the service of a whole-time cooly.

"I was dissatisfied with the working of the installation, the cost of which was, I considered, excessive.

"The estimate submitted by the Engineer in charge was as follows :—

Total cost of working per day of 8 hours.				Quantity of water raised in gallons per hour.	REMARKS.
Daily.	Rs.	A.	P.		
Anchor Brand Oil	4	7	0	Maximum delivery per hour with valve full open, 4,800 gallons.	This engine is larger than is required by the pump, so the upkeep is more than would be necessary if the pump and engine had been properly proportioned.
Castor Oil, ½ bottle...	0	4	0		
Cocoa Oil for cylinder, ½ bottle...	0	4	0		
Cotton waste, 1 lb.	0	3	0		
Miscellaneous, soap, etc.	0	2	0		
Total ...	5	4	0		

Driver on Rs. 15 p.m., As. 8 per diem.
Cooly on „ 10 p.m., „ 5 „ „

Total Rs. 6-1-0 per day.

(Sd.) ALFRED E. JOYCE,
Asst. Engineer in charge,
P. W. D. Workshop.

"On taking over the installation I got certain economies introduced which reduced the total cost of working to Rs. 3-14-0 per day of six hours when kerosine was used.

"One fact is that in this case a mistake was made in ordering a pump that was too small for the engine.

"In paras. 2 and 3 of Mr. Chatterton's letter great stress is laid on this point, and Mr. Chatterton states that nothing less than a 3″ centrifugal should have been used. But I find from correspondence between him and my department that he recommended for this well, a 2″ centrifugal pump driven by a 5 b.h.-p. or a 3″ pump driven by a 7 b.h.-p.

"In para. 3 Mr. Chatterton admits that under the circumstances described a 5 h.-p. engine and a 3″ centrifugal pump would not be fully employed, and that an ordinary mhote would approximately lift as much water in a working day. In the case of the oil engine much time and money might be wasted if even a small piece of machinery got out of order as no local arrangements exist for repairs.

"Regarding para. 4, I should like to point out that the figures given by me for the cost of working a mhote applied to

the conditions which exist in these Provinces. The bullocks that work in the mhote during the dry weather are kept fully at work in rice cultivation during the rains, so that at no season are they idle as Mr. Chatterton would seem to suppose. As regards cattle requiring a day's rest now and then when worked in the mhote while the engine driver is supposed to work continuously, this also is a mistaken idea. My experience is that bullocks can be worked continuously in the mhote for six hours per day, *i.e.*, (the time on which my calculation was based) if allowed to move at a slow pace all the time—the pace required to raise 56 mhotes per hour from a depth of about 25 feet.

"The engine driver, on the other hand, is a much less dependable asset, and does take a day off now and then.

"I am rather of the opinion that at present there is no place for oil engine and pumps in these Provinces. For lifts exceeding 20 feet the mhote does the work cheaply and well; for depths of less than 20 feet the chain pump driven by a gear will lift water more cheaply than Mr. Chatterton's most efficient installation.

"It may be that in future workshops will be started where repairs can be done and where boys can be trained in engine driving; but at present such mechanics are not available, so that if this method of lifting water were adopted, the cost of repairs would be excessive. Moreover, the initial cost would deter cultivators from such an investment."

The Director of Agriculture, Central Provinces, sends the following remarks:—

"I agree with Mr. Chatterton that this is a bad example of such installations: but his criticism appears to me to be unjust, for it was on his advice that an engine too large for the pump was installed. At the same time it is impossible for me to reconcile the figures of actual cost of working with those given by the Executive Engineer, Raipur.

"On the general question, my opinion with that of Mr. Clouston agrees fully.

"An installation of this type would, no doubt, pay if owned by a man who actually understands machinery, and can do his own petty repairs. A tenant cannot afford to pay a highly skilled mechanic : and moreover, he is too remote, as a rule, from skilled advice to supervise and control his man's work ; for any trifling repair a mechanic must be conveyed to the engine and paid his fee, and small sums under these heads will produce a big total at the end of the year. On the other hand, any local *mistri* can make or mend a chain pump. At the present time I do not think that these installations can be introduced in the Provinces for agricultural purposes."

THE INTRODUCTION OF DRILL-SOWING AND INTERCULTIVATION ON TO THE BLACK COTTON SOILS OF TINNEVELLY, MADRAS PRESIDENCY.

By H. C. SAMPSON, B.Sc.,

Deputy Director of Agriculture, Madras.

In 1907-8, the Government of Madras gave an allotment of Rs. 5,000 for the improvement of cotton cultivation, and it was decided that a part of this sum should be utilised in introducing the practice of drill cultivation for cotton into the Tinnevelly District.

To some extent, the way had been prepared. This method of cultivation had been introduced on to the Koilpatty Agricultural Station, and in the 1906-7 season, after this station had been enlarged, there were 51·35 acres of cotton, all sown with the drill. The crops which were much superior to those outside the farm began to attract attention in the neighbourhood. In March 1907, when the cotton-picking was at its height, Mr. Couchman, Director of Agriculture, and Mr. Wood, Deputy Director of Agriculture, who then had charge of this division, when inspecting this station, assembled the neighbouring *ryots*. The methods of cultivation were explained to them, the farm crops were compared with those outside, and the implements were shown at work and even handled by the *ryots*. Several of them there and then promised to try this method of cultivation if assistance were given them. The very roughness in the workmanship of the implements pleased them, as such work could easily be turned out by their own carpenters and blacksmiths. But a promise given when the crop is ripe for picking is a very different thing to its

PLATE XX.

A. J. I. I. Broadcasted and Drill-sown Field, with Owner, at Pallikkottai.

fulfilment at the next sowing time, and there were many obstacles to be overcome before such a revolutionary change in the methods of cultivation could be brought about. A brief description, therefore, of the people and the local conditions, and the method of cultivation which it was wished to introduce, seems necessary. The black cotton soil cultivators of this district are both Telugus, who, it is said, came south during the time of the Vizianagar and Naick dynasties and settled in the district, and Tamils. The Telugu is noted throughout the Presidency for his love of the black cotton soil and throughout the whole of the Tamil country, Telugu villages are to be found wherever there is any extent of black cotton soil.

In two of the three Taluks which adjoin the Koilpatty Agricultural Station, *viz.*, Ottapidarum and Satur, the vernacular of one-fifth and one-third, respectively, of the total inhabitants is Telugu, and when one bears in mind that this race is almost entirely confined to the black soil areas, the proportion who cultivate cotton must be much greater. The chief Tamil castes are the Vellalas, Pallars, Maravars and Shanars. The first two are both good cultivating castes. The Maravars also cultivate, but depend also on dacoity and cattle-lifting and are, therefore, not so thrifty. The Shanars are the toddy-drawing caste and are excellent petty cultivators, growing irrigated garden and cereal crops under wells. Thus, the introduction of any improvement has to be repeated in almost every village, for it by no means follows that if one village adopts an improvement, the next village, if of a different caste, will follow its example. And besides the natural conservatism of the *ryot*, superstition and fear of offending the deities have also to be overcome. As an example of this : in November 1907 a very heavy rain of more than 7 inches fell on one day and breached several tanks, besides doing considerable damage to the standing crops on the black soil. As a result, some *ryots* refused to work the bullock-hoes in their drill-sown crops, as they said that this rain was a signal of divine wrath. One man actually ploughed up his crop.

The present agricultural practice on the black soil was dealt with in detail in the Scientific Report of the Koilpatty

Agricultural Station, 1907-8. From this it will be seen that the Tinnevelly black soil *ryot* is an excellent cultivator. Suffice it to say here that instead of sowing cotton broadcast, covering with the plough and doing the after-cultivation with hand-hoes, we wished to introduce the practice of sowing in rows with the bamboo seed-drill, covering the seed with the blade cultivator and doing the after-cultivation with the small blade bullock-hoes. All these implements, though common in the Northern Districts and in other parts of India, are unknown in the south of Madras.

When it was decided to take steps to introduce this system of cultivation, there were only two coolies in the district who knew how to work these implements, and these were only local men who had been trained on the Koilpatty Agricultural Station and who only knew that particular class of soil. Therefore, it was decided to bring down men who had been used, all their lives, to these implements from the Bellary District. Accordingly, some 26 sets of implements were made during the hot weather months, ready to be lent out to *ryots*, and six Bellary men were sent down at the beginning of September (six weeks before the sowing season). Five of these only reached their destination; one being afraid to go so far from his native country, left the train at the next station after its departure and went back home. These men were purposely brought down early in the season, so that they could become accustomed to the South Country bullocks and could train the other coolies, employed in the Agricultural Station. It proved afterwards that it was well that this precaution had been taken, for these men were, with one exception, only of use in training the local farm coolies under the supervision of the farm staff. They proved to be just as conservative, in their own way, as the *ryots*, whom they had been intended to teach. They were unable to handle or drive the bullocks which were unused to the noises made by them when driving. In fact, several *ryots* refused to let these men continue working, as they could not drive a straight furrow and preferred the newly trained local coolie who was used to their local cattle.

PLATE XXI.

A. J. I. II. Broadcasted and Drill-sown Field, with Owner, at Pallikkottai.

This was not the only objection to these Bellary men. They knew no Tamil, and their language was a mixture of Telugu and Canarese, so that they could only make themselves understood in the Telugu villages. Also their different customs and unthrifty habits at once prejudiced the Tinnevelly *ryot* against them.

During the first year of the introduction of these implements, the Manager of the Agricultural Station selected the adjoining Telugu village in which to concentrate his efforts. The selection was a good one. The Telugu, who is comparatively a recent arrival in the district, is not so bound down to custom as the aboriginal Tamil, and it is easier to get him to try improved methods. The village mainly depended on its black soil which was, on the whole, excellently farmed land. Some sixty acres were sown with the drill last season and some excellent crops obtained. In one or two other neighbouring Tamil villages, small areas of four or five acres were sown. In one case, the owner of the land quarrelled with the whole of the rest of the village for introducing something new, but they were appeased when they saw his crop, and this season in the same village more than seventy acres have been sown with the drill. In the first year, about 200 acres were sown on *ryots'* fields with the drill.

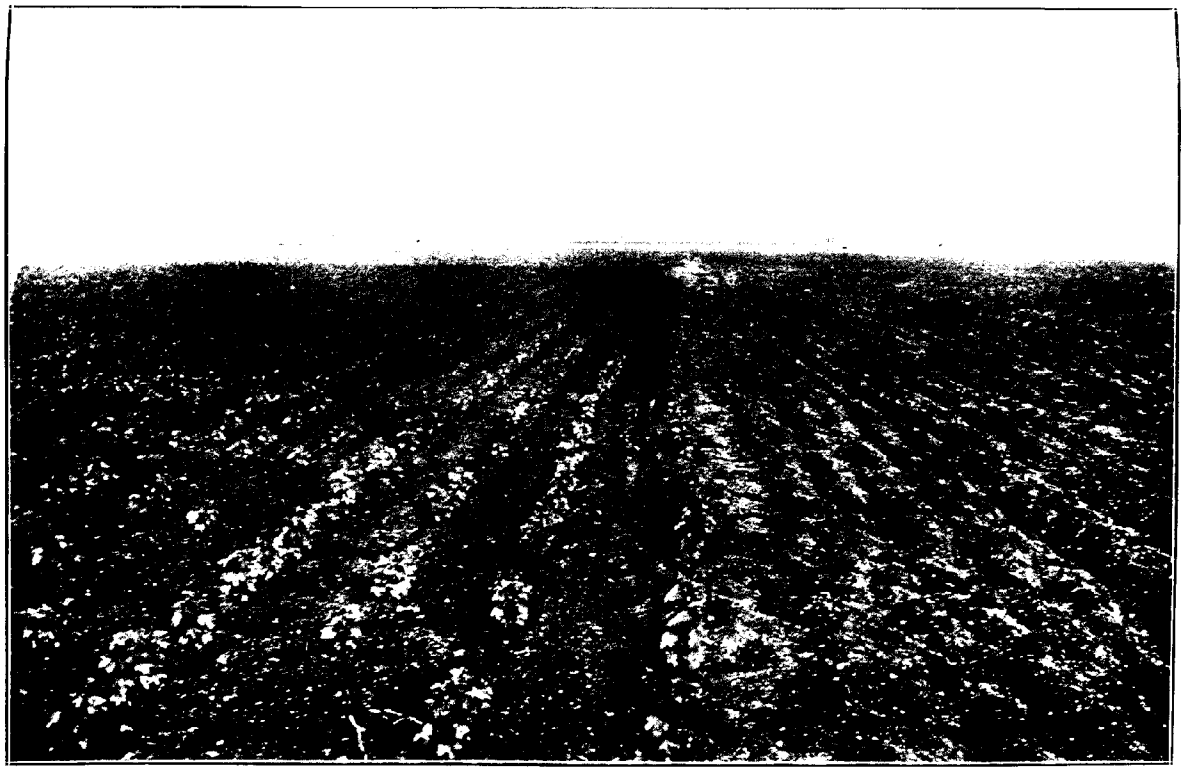
In the year 1908-9, a similar allotment was made for cotton improvement, and it was decided to continue this work as well as to introduce seed-farms for growing pure Karangani cotton of the strain selected on the Koilpatty Agricultural Station. This gave an opportunity of spreading this system of cultivation further afield than Koilpatty, but was a much more difficult matter to arrange, as in many parts of the district, the Department was unknown, and the Agricultural Station at Koilpatty had not been heard of.

In order to cope with this work as well as the extension, probably on the success of the previous years' operations, several new hands had to be trained. This meant a very careful selection on the part of the Manager at Koilpatty, and many of the would-be sowing experts had to be got rid of after a trial. Besides this, the Manager had to bear in mind the villages in

which the extension would probably take place and to train either a man of that village or a man of similar caste. The best men, it was found, were petty *ryots* who owned land in the village where they were to work. They, as a matter of course, looked after their own interest and sowed their own lands first. This new introduction naturally attracted much attention in the village and gave others confidence in the practice. When the sowing season commenced, there were some 22 trained coolies available. Their training was by no means complete, as they had only been taught to sow in dry land, at first with coarse sand, and afterwards with boiled cotton seed. Thus, they had never seen any crops which had come up with their sowing and had never sown in a moist seed-bed. It was necessary, therefore, for one of the staff to be present at the commencement to see that the work was started properly.

The seed-farms were, however, the main outside centres of the introduction of this improvement. Five centres had been selected in different parts of the district, and to each of these trained coolies were sent with a set of implements. My Assistant, M. R. Ry. J. Chelvaranga Raju, had charge of this work and made the necessary arrangements with the owners of the land. The terms on which this was obtained were as follows :- The land selected should not have grown cotton the previous season and would be required for one season only. The Government should pay the assessment, provide the seed, sow it with the drill and do the subsequent bullock-hoeing when necessary. The *ryot* was to do the primary cultivation, was to pen the land with sheep and was to do any hand-weeding, was to thinly crop as directed and was to sell to the Department the main season *Kappas*, well-dried, at Rs. 4 per candy of 500 lbs. above the market price. It was interesting to follow each of these seed-farms, as each was worked under different conditions. The most satisfactory was at Pallikkottai, a Vellala village, where thirty acres of cotton were grown for us. The land belonged to several owners in the village, each contributing three or four acres. No man in the village owned or rather farmed more than 15 acres, and most of

PLATE XXII.



J. J. I. SHOWING ON THE LEFT THE DRILL-SOWN CROP; ON THE RIGHT, A BROADCASTED CROP SOWN ON THE SAME DAY.

them had to depend on this for a living. Thus, we had excellently farmed land to deal with. At first the *ryot* thought that he was risking a great deal, having never seen anything but his own cultivation before, but afterwards, when he saw the germination and subsequent growth, he looked after his share of the cultivation to the best of his ability. We were ingeniously told when inspecting this area that next year we could have our pick of the best lands in the village if we wished to grow cotton again, implying that this year they had given us anything but their best land. This village had already ordered two shares of implements to be made for them in Tinnevelly. Plates XX and XXI show a broadcasted and drill-sown field in this village with their respective owners. It is unfortunate that the light and shade in the two pictures are not the same. The trained coolie who looked to the sowing of the seed-farm had also to sow land, for people wished to try drill cultivation on their own account, but this was confined to another village some ten miles away, as the people of Pallikkottai thought at the sowing time that they were already risking enough in growing seed for us. Though 30 acres of seed-farm are allowed for each trained coolie to manage, if we had not been particular about getting the seed sown in good time, he could have sown a larger area. Therefore, this demonstration work was also added, as it was thought that a man of this class would be spoilt if he were allowed to idle his time. In the village where the demonstration blocks were, some inducement was necessary to get people to try this. My Assistant offered to sow an area of 3 acres of land with two pairs of bullocks at the same time that one of the *ryots* who had just commenced sowing broadcast in the next field of similar area would with seven pairs. This offer decided the owner, and the work was completed in both fields at the same time. I saw the crops on inspection two months after sowing. No rain had fallen since sowing till a few days before. In the broadcasted field, there were a few stray plants, and the other seeds were just germinating. In the drill-sown field, there was an excellent stand.

In the next seed-farm at Maniyachi, it was only with the Tahsildar's influence that people unwillingly consented to grow seed for us; 20 acres belonging to three owners were sown and naturally they gave their worst fields for the purpose. Cattle could only be hired to work the implements through the influence of the village headman. Sowing was, however, completed on November 11th, having been delayed by previous incessant rain, and no more rain fell till the end of January. Plate XXII shows on the left hand side the drill-sown crop, and on the right a broadcasted crop belonging to the same *ryot* and sown on the same day. The latter had just germinated, but the plants are too small to show in the photograph which was taken on January 11th. Here, again, the owners wished that they had given better land and are anxious for us to sow again next year on a more extensive scale. The third seed-farm at Mullakulam belongs to a retired Government official, who, until now, has leased out the land on a yearly lease. The land here is poor and very shallow, and, as a result of the system of lease, very foul with weeds, but this year we had to be content with what land we could get. Here one of the objections to locally trained coolies was met with. The man had been used to sowing on the fairly deep soil of Koilpatty, and coming here he sowed at the same depth. Heavy rain soon waterlogged this shallow soil, and germination was spoilt. One of the owner's own servants, an excellent Telugu cultivator, was trained locally to assist this coolie sent from Koilpatty, and he, knowing the land evidently, sowed accordingly, as his sowings gave an excellent stand. The owner has done everything to assist with his share of the work and has now got the land fairly clean, so that next year his labour will not be lost. Demonstration plots in the neighbouring village of Telugu cultivators have given excellent crops, one of the best that I saw in the course of my last inspection.

The fourth seed-farm of 30 acres is at Nainapuram. Here the owner is a rich man, and with the help of his son and an agent, attends to the cultivation himself. This has not been inspected by me as yet, but evidently the crop has proved

satisfactory, as the owner has already ordered a set of implements to be made for him for next season. The fifth seed-farm is at Ettayapuram on one of the zamindar's Home Farm lands. This is 100 acres and the largest of all, but here work is not so easy as it is when the land belongs to smaller *ryots*. The land is not so well cared for, and all the work has to be done through the managers of the several Home Farm lands, while the Home Farm coolie establishment naturally follow the lead of their master. This much depends on whether the manager happens to favour the work. This seed-farm is doing well, and the *ryots* of the village say that this land has never borne such a good crop, but, at the same time, it shows a striking difference to a 20 acres block which the zamindar's uncle has grown for seed for us. The owner attends to all the details of his cultivation himself and has sown our seed with the drill, but though quite willing to grow seed for the Department, does not care to accept even the assessment. This gentleman frequently visits the Koilpatty Agricultural Station and takes a keen practical interest in what he sees there. He has also had a set of implements made locally for his own future use. His crop was the best I have seen this year.

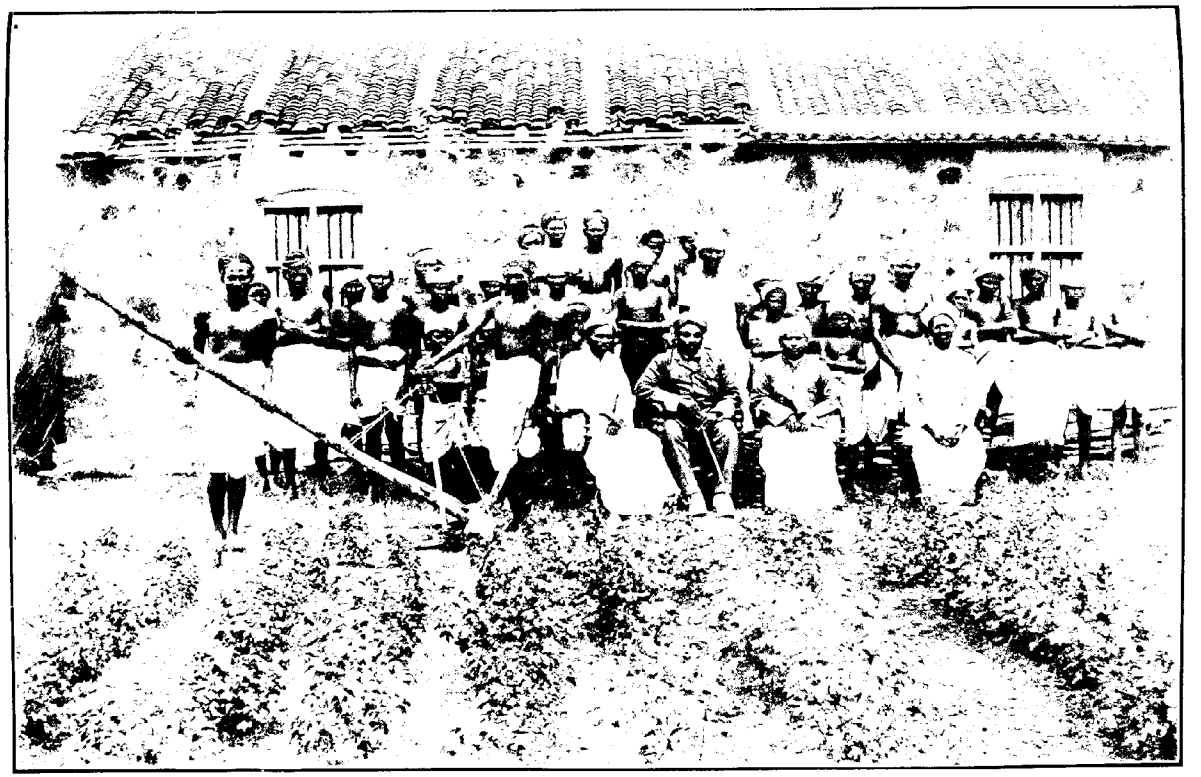
As these seed-farms were in a way the forerunners of the extension of drill cultivation, the very best of the trained coolies were sent to these. A mistake, however, was made in one or two cases in not making proper arrangements for the welfare of these men. All of them were Pariahs or low caste men, and consequently in some cases they had rather a rough time of it. The sowing season is the commencement of the rains, and there is a great fall in the night temperature after rain. In consequence, several of the coolies fell sick with fever and had to be replaced by inferior men, and even these could ill be spared. In future, arrangements will have to be made in the village to house these men properly and to arrange for their food being prepared at a fixed rate.

Apart from these seed-farms and the demonstration plots in their neighbourhood, there has been a rapid extension of drill

sowing in the villages around Koilpatty, where some 500 acres have been sown. One village alone accounted for more than 230 acres, while two more each had over 70 acres. In a few cases, outlying *ryots* have also sown, having either seen the farm crops last year or the crops of *ryots* who had sown with the drill the previous season. Including the seed-farms, there is an area of about 1,000 acres this year sown with the drill.

The mere fact of sowing is, however, by no means everything. Each *ryot* who has sown has to be seen constantly. He has to be induced to thin and shown, when and how, to use the bullock-hoe. As the thinning and, very often, the hoeing clash with other farm work, the *ryots* are often unwilling at the time to do so. They may make promises, but they do not always fulfil them. This means considerable patience and tact in dealing with them. Thinning especially goes against the grain, for the *ryot* says "It is like taking the life of my children to pull these plants which have grown," but still this must be done if this system of cultivation is not to degenerate into that of the Bellary District where the seed-rate is more than double that used in Tinnevelly and no thinning is done. Many of the wives and children of the Koilpatty coolie staff who are employed for casual labour on the Agricultural Station, have had to be pressed into service and sent out with one of the Assistant Managers to show *ryots* how to thin their crops. Small boys are probably the best, as their youth favours them in their training, and they can do the work with that unconscious confidence which always appeals to a *ryot*. With all the success already obtained in this introduction, it is by no means certain yet whether this method of cultivation, if now left to itself, would last. The questions which next present themselves are: (1) when should the Department withdraw its help, and (2) how to leave the work on a substantial basis. This is, of course, looking into the future, but it seems necessary that the Department should give some concession, but only if the *ryot* will do the same. The proposal next season is that the Department should lend one set of implements to the village for every one that the village is prepared to make,

PLATE XXIII.



A. J. L. STAFF OF KOILPATTY AGRICULTURAL STATION.

provided that 60 acres are sown with the two sets, and if the villagers among themselves guarantee to sow 200 acres with the drill, the services of a trained coolie will be lent to them for the season. To a very great extent, the success so far attained, has depended on the Manager and the Assistant Managers of the Koilpatty Agricultural Station. The Manager, M. R. Ry. A. V. Tirumuruganatham Pillai, has only been at this station for 3¼ years, joining as an Assistant Manager. On 14th December 1906, he was put in charge of the station, and it says much for him that he, not being a native of this district, should, in that time, gain the confidence of the neighbouring *ryots* as well as the loyal support of his Assisant Managers, and that he can entrust his own coolies, most of whom are Pariahs, to carry out his instructions when sent out into the district. The success of the seed-farms from the very first has largely depended on the untiring efforts of my Assistant, M. R. Ry. Chelvaranga Raju. It is no easy matter to supervise work in five separate centres scattered over four Taluks, especially when one has to travel through black cotton soil country in the monsoon season. Plate XXIII shows the staff who are carrying out this work. One of the Assistant Managers is not present as he is out on tour. The coolies represent the temporary establishment utilised both on the Agricultural Station and in the district. Many of them are not fully trained yet, as this includes the boys employed for thinning and for guiding the bullock-hoes.

NOTES.

PINE APPLE INDUSTRY IN INDIA—In recent years, the demand for Indian-grown pine apples has so greatly increased that an effort should be made to establish this industry on a commercial scale.

The pine apple is grown extensively in many parts of India and Burma.

On the Malabar Coast, in Northern Bengal, in Assam and in Burma, the pine apple produces fruit of very good quality.

On the Khasi Hills in Assam, it grows excellently and yields a fine fruit.

There has been no particular effort made to develop the cultivation of the fruit on a commercial basis. Therefore, pine apples from the Straits Settlements, Ceylon and Mauritius, find a ready sale in India at remunerative prices.

A warm moist atmosphere, a fairly high rainfall, a friable soil and a porous sub-soil appear to be best suitable for pine apples in India.

Pine apples in India thrive well on soils which have been improved, in forests, by partial clearing and by the natural addition through rainfall of leaf mould. A friable moist soil with a fairly high proportion of organic manure is apparently essential for successful cultivation.

Pine apple plantations, when established 3 or 4 years, should be removed to suitable areas with the view of improving or renewing the vigour of the plant.

When the fruit is formed, numerous suckers grow round the parent stem. These can be used for propagation. Plants may

also be raised from the crown of leaves of the fruit, and from the black seeds of the fruit.

In plantation, the suckers should be planted in rows 3 feet apart.

In Bengal, the season for planting out pine apples is August. The plant there flowers in February and March, and its fruit ripens in July or August. In September and October, it makes its perfect growth.

Each fruit should be cut off with a sharp knife through the middle of the stock, a little before it is fully ripe, and for export should be very carefully packed in soft material, and in ventilated boxes to avoid fermentation and bruising.

The leaves yield a good fibre. In the London market it fetches about £30 (Rs. 450) per ton. In the Rangpur District of Eastern Bengal and Assam, the fibre is largely used by the shoe-makers as string. In the Southern Mahratha country and Goa, it is used for necklaces. The Fibre Expert to the Government of Eastern Bengal and Assam is, however, of opinion that the extraction of fibre from pine apple is not likely to be an extensive enterprise in any part of India—(EDITOR).

* * *

THE REARING OF EDIBLE FROGS.—Frog is a food-stuff in America, and its consumption in the United States is, according to the Commissioner of Fisheries for Pennsylvania, twice as much as in France. Frog farming might be a lucrative Indian industry in the future, if Indian farmers invest their money in this industry and utilise their waste and swampy lands, which they cannot otherwise make use of. On account of the great demand in the Foreign market, it can be made profitable.

The method of frog rearing is simple. In the beginning, a small pond about 60′ by 20′ should be made, in which to hatch the frog eggs and care for the tadpoles until they have developed into frogs. During the time these tadpoles are developed, at least three more ponds about the same size must be made, in which to place the crop of young frogs. When they

become two years old, they should be kept in separate ponds as they devour each other, as for instance, three-year old frogs eat one-year old frogs, and so on.

In order to protect them from snakes, water beetles, birds, such as cranes, herons and owls, the ponds should be fenced properly and watched. When three years old, they become ready for market—(M. A. RASHID).

* * *

SIDA FIBRE.—The *Indian Textile Journal* for November 1908 contains a long article on "Sida : a Substitute for Jute."

Sida has long been known as a fibre of considerable merit. In 1853, Major Hannay, of Assam, drew attention to it, and pointed out its various advantages. Efforts to popularise its cultivation were, however, not successful, chiefly perhaps, owing to the growing demand for jute : but partly also, no doubt, owing to certain difficulties regarding its cultivation. One of these difficulties is the hardness of its seed, which refuses to germinate unless specially treated before sowing. Such hardness of the seed can easily be overcome, of course, by treatment with Sulphuric Acid, which attacks the hard coating and renders it permeable to water which promotes germination. Good germination can also be procured by treatment in a machine such as is used for the similarly hard seed of Java Indigo. These conveniences are, however, not at the disposal of every cultivator, and it is certain that, before any considerable extension of Sida cultivation could take place, a simple means of promoting germination must be prescribed. Experiments with this object in view, carried out in the laboratory of the writer of this note, now indicate that success may be realised by immersing the seed in hot water for a short time. A fifty per cent. germination has already been obtained from seed of which only 3% germinates before treatment, and it is hoped that more satisfactory results still will accrue from further work.

It may be remarked here in passing that a hard coating is very common indeed in the seed of jungle plants in India.

Moreover, it has been noticed that some cultivated plants when allowed to run wild, tend to produce hard seed in a comparatively short time, a fact which indicates the possibility of performing the reverse process in the case of Sida by careful cultivation and selection.

Another difficulty in cultivating Sida has, up to the present, been the great tendency towards branching which it exhibits, a habit which is, of course, an important disadvantage in a plant to be used for fibre production. At first it was thought likely that the difficulty could only be overcome by careful selection and breeding of a non-branching race; but Dr. Butler, the Imperial Mycologist, when touring in Burma, accidentally discovered a straight growing variety of Sida, which gives promise of solving this problem in a much easier manner.

Several varieties of Sida are to be found in various parts of India. The commonest are, perhaps, *S. rhombifolia* and *S. carpinifolia*; others less common are *S. veronicæfolia* and one which has been variously named, *S. spinosa* and *S. cordifolia*. This last and *S. rhombifolia* seem to yield fibre of better quality than others.

Regarding the merits of Sida, as compared with other fibres, Messrs. Cross and Beven, of London, found that one sample examined by them contained 83% of Cellulose as against 75% for jute. Such a high percentage of Cellulose would place Sida on a level with *Rhea* and flax, whereas the writer's results indicate so far that jute and Sida are very similar as regards Cellulose content.

It may be pointed out that Cellulose is the ingredient in a fibre which makes for durability.

Nevertheless, although Sida is probably nearer to the standard of jute than to that of flax, as regards quality, there is reason to believe that its fine texture would enable it not only to replace the higher classes of jute, but even to be used for purposes for which jute would be unsuitable. Two years ago, the Indian Jute Mills valued one sample of Sida at Rs. 11 per maund, when the average quoted value for jute was Rs. 8 per maund, and more

recently, another sample has been valued in London at from £ 25 to £ 30 per ton with good to fine jute at £ 16 to £ 25 per ton. These figures are encouraging, but it must be remembered that Sida will probably never be capable of yielding such a weight of fibre per acre as jute. Moreover, the expenses of cultivation are likely to be rather higher than for jute. The writer has obtained over six maunds per acre which, with the longer and straighter plant recently discovered, may be increased to ten maunds per acre. Such a yield might pay quite well. At the same time, having regard to all considerations, it would appear that the time has not yet come to recommend Sida for commercial exploitation as a fibre plant. It may be possible to do so after a short time; but until the points at issue have been decided, such a course would probably rather hinder than help the development of a fibre which may easily have a great future in the textile world.—(R. S. FINLOW).

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VISITORS TO AGRICULTURAL COLLEGES AND FARMS.—The Government of Madras have appointed, for two years, 15 non-official gentlemen of the Presidency, who take a practical interest in Agriculture, as honorary visitors to the Agricultural College and Research Institute at Coimbatore. The College and Farm will be open for their inspection at any time except on Sundays and on Government Gazetted holidays, and an officer will be deputed to show them anything they may wish to see and to afford any information regarding the object of any experiments that may be in progress. Every honorary visitor intending to visit the College or Farm shall ordinarily give the Principal 24 hours' notice of such intention.

A visitor's book will be kept in the Principal's office in which the visitors may enter any remarks and observations they may wish to record regarding the work in progress in the College or Farm. Copies of remarks recorded by visitors will be forwarded, by the Principal, once a quarter, to the Board of Revenue through the Director of Agriculture.

Somewhat similar arrangements might be followed in the other Provinces with advantage—(EDITOR).

* * *

COTTON CULTIVATION IN MADRAS—The Government of Madras sanctioned the proposals of the Director of Agriculture for the utilisation of a grant of Rs. 5,000 provided in the budget of 1908-9 for the improvement of cotton cultivation in that Presidency. The Director proposes to confine the expenditure almost entirely to the Tinnevelly District and to spend a small sum in Trichinopoly.

Experiments have shown that *Karangani* Cotton is superior in quality and a more paying crop than the *Uppam* variety. Arrangements were, therefore, made last season to distribute pure Karangani seed sufficient to sow about 7,000 acres. The *Kapas* was ginned by the department, and the lint sold, the seed being kept for distribution.

There was a keen demand for seed. About 250 acres of *ryots'* land were sown with selected seed under departmental supervision. The ryots were refunded the assessment of the land, and the agricultural department provided one trained coolie and one pair of locally hired bullocks at sowing time for every thirty acres. In this way improved methods of drilling the seed and of interculture were demonstrated. Careful preliminary tillage and manuring were insisted on.

The advantages of the drill are becoming widely appreciated, and in all, 1,000 acres of private land have been sown with the drill this year, about 400 acres of which are in the village in which the Koilpatty Government farm is situated. The facts that with the drill a much larger area can be sown in a given time than with the plough, and that sowing can be continued longer after the rain stops, are beginning to be understood by the *ryots*. Many ryots have learned to use the drill and have taught their women to sow the seed. Mr. H. C. Sampson, Deputy Director of Agriculture, writes :—

"The introduction of this system of cultivation is, I consider, the most important work that is being done. In seasons of

drought, such as this, the *ryot* has to depend almost entirely on his cotton crop for his livelihood, and if he can be shown that this system of cultivation can help the cotton crop to withstand the drought and to give even a fair crop in such seasons, it may mean all the difference between scarcity and famine."—(EDITOR).

* * *

MILK RECORDS—An interesting paper on this subject was lately read before the Farmers' Club by an Essex dairy farmer, in which were some remarkable figures showing the results obtained by a systematic selection of the milking herd. On one day in each week the milk given by every individual cow was carefully measured and recorded. Not only did this practice enable the owner to estimate with considerable accuracy the profit and loss on each cow: but it was also of greater value as a guide to show from which cows the calves should be reared. Thus, the selection of the cattle from which to breed was based almost entirely upon the milking capacity of the cow, and a good 'milk'—rather than a good show—pedigree was desired. The other factor necessary for the improvement of the herd was a supply of sires from a good milking stock, that is, bulls from other herds where the same or similar records had been kept. In the paper read it was emphasized that a 'good-looking bull,' or even a pedigree bull, if from a herd bred simply for beef or points, was not necessarily of any value: all that was required was one whose female stock would probably be better milkers than their dams.

By carefully selecting and breeding on these lines, the speaker had improved his stock to such an extent, that he now owned heifers which, at two and a half years old, after giving birth to their first calf, gave fourteen quarts of milk a day instead of the ten to eleven quarts that were the record for the same class a few years ago.

The ideas and methods advocated in the paper are not new, and some such selection is now carried out by most of the larger dairy farmers with more or less success. But the point that

is worthy of note by readers in this country is the result achieved. And if, even among the more highly selected cattle of England, whose milk producing powers have been continuously forced, so marked an improvement can be made within so short a time, then surely, it is reasonable to expect yet better results from an Indian herd if carefully and systematically selected to that end—(G. SHERRARD).

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CULTIVATION OF WILD RHEA—Wild Rhea is identified by the Hill tribes of Assam as the *Villebrunea integrifolia* plant. This is found profusely at the foot of the Eastern Himalayas from Sikkim to Nepal, throughout the Valley of Assam, especially near the foot of the hills and within the Assam Hills from the extreme north through the Naga Country to the Khasia and Garo Hills, thence to Manipur, Cachar, Sylhet and Chittagong, also in the mountainous tracts of Burma as far as Tenasserim and to the Yunan Province of China, in the damp valleys of the higher Konkan Ghats and even in the Andaman Islands. It grows in damp glades near streams, but its roots are always above water. It is extremely pollarded, and a place called *Riha-Kaia-Jan* is said to be the head-quarters of the Mikir collection and preparation of this bauriha-fibre. It is said to be an indigenous plant and quite distinct from the cultivated Rhea. Expert investigation has shown that the fibre of this plant is exceedingly fine as compared with that of ordinary Rhea, its filaments long and strong, and its material capable of producing finer textile fabrics than *Boehmeria nivea*, and a good substitute for fine linen.

In making cloth, it is mixed with silk. In the village markets of Assam, the Garos who principally deal in the fibre, sell it at Re. 1 per seer. The stems which yield the fibre are obtained by cutting down the plants during the months of November to February. Young shoots again sprout in June and during the rains. The fibre is extracted from the branches in the same way as from *Boehmeria nivea*. The Assamese take off the ribbons

when the shoots are half dry and do not first scrape off the outer bark or gum. They leave the inner face coated with slimy green and purify it in a coarse way by washing in lime and then twist it into twine or simply divide up the ribbons and without any preparation, twist these into twine to be used for making nets for catching gang.—(S. C. SANIAL).

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CULTIVATION OF MAIZE IN THE PAKOKKU DISTRICT OF UPPER BURMA.—It is a curious fact and one, I think, not widely known that Maize (*Zea mays*) is entirely grown in this district, and I think I may say, all over Burma, for the wrapper which envelops the cob, and not for the grain found on that cob.

This wrapper or "pet" as it is called by Burmans, is used for cheroots; not the Burman cheroots known as such out of Burma, which are smoked usually by non-Burmans, but for the cheroots actually smoked by Burmans.

These consist of a quantity of coarse tobacco leaf and stalk chopped up and mixed with chopped wood of the "Ohnnebin" tree (*Streblus asper*) wrapped in a fold or two of "pet," or in the leaf specially prepared of the "thanat-bin" (*Cordia myxa*).

That the demand for "Pyaung-bu-pet," *i.e.*, Maize "pet," is great, is proved by its price.

All that is exported from the district finds its way out through Pakokku town, where it is shipped on board the steamers of the Irrawaddy Flotilla Company, and carried down to the delta. In the town of Pakokku the price of the best "pet" is Rs. 100 per 100 viss of 3·66 lbs. each.

It is mainly grown in the western townships of the district. The local price varies from Rs. 50 to Rs. 70 per 100 viss, that is, the price in the villages in which it is grown. The crop is put down in June and ripens in October-November. The cobs, as they ripen, are broken off the stalks on which they grow. The wrapper is then carefully cut off each cob and tied up in neat bundles of from one to one and a half viss each. It is said that the work of cutting off the "pet" and tying it in

bundles is not easy. The process certainly looks very simple. Men are hired for it, and the regular hire is Re. 1 for 10 viss. The maize cobs are sold, and for the last three years, have been the means of staving off dire distress in the eastern townships of the district. The demand for them, as a food, has caused their price to rise as high as Re. 1 for three baskets. The cobs are sold; not the grain only without the cobs. The grain is not relished by Burmans as a food, and only the fact that no other food is obtainable, induces them to eat it. This, I think, is due to the fact that the cookery science of the Burman is common with all Indo-Chinese races and is confined to the art of boiling.

Rice, millet, meat, vegetables are all cooked by boiling, and maize grain, after the hard outer shell has been removed by pounding, is cooked in the same manner. It would probably be far more palatable, if reduced to flour and baked into bread or cakes.

Those fortunate enough to own maize-growing land would laugh at the idea of eating maize grain.

The crop is a very paying one. The yield per acre ranges from 30 viss to 60 viss, and many plots yield as much as 100 viss to the acre. The number of baskets of cobs from a given area is almost identical with the number of viss of "pet."

I was told on my first arrival in the district in October 1905 that the cobs with the grain on them were often thrown away. —(F. C. Owens).

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Selection of Sea Island Cotton in Georgia, United States of America—About 1785 seeds of this cotton were brought to Georgia from the Bahamas. Notwithstanding the good care they received and the mild winter, the plants were killed down, but they came up again from the roots, and with this start succeeded in ripening a few seeds before the first frost in the fall. The earliest of these seeds were sown in turn, and by continuing this process of selection the flowering period became earlier and earlier, until now the plants ripen a large portion of their seeds

before frost, even along the Coast of Carolinas. Besides striving to obtain earlier maturing sorts, very careful selection has for years been made with a view to increasing the length, fineness and strength of the staple. The selection is regularly practised by all intelligent growers, and to-day it may be regarded as one of the necessary cultural methods. Every year a special patch of cotton is grown from selected seed; the plants in this patch are examined very carefully and the seeds of the best individuals retained for planting a similar patch next year, the seeds of the remaining plants being used to plant the general crop. Under such continuous and rigorous selection the length and fineness of the fibre have gradually increased until it is recognised as superior to that grown anywhere else in the world, and commands the highest price in the market. *It is, moreover, only by such selection that the quality of the fibre can* be maintained at its present superior standard. This method of selection and similar ones are applicable with slight variations to most of our common crops, such as maize, wheat, etc.—(W. ROBERTS).

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SERICULTURE IN JAMMU—The soil and climate of Jammu are quite suitable for the growth of Mulberry trees on a large scale. *Morus nigra* is absent in the sub-mountainous districts and in the plains, but *Morus alba vulgaris* is plentiful. *Morus serrata* or the fruitless Mulberry trees are also common in Jammu and afford good food to the *Bombyx mori* or the Mulberry silkworm. The grafted *Morus indiga* or the Shahtut is found in many gardens, but it does not make good food for the silkworms at the beginning of its growth. It may be used just before the silkworms ascend for seri-depositing.

The common *Ber* (*Ziziphus jujuba*) tree, the good food for *Antheræa myletta* or the Tussar silkworm, grows largely in Jammu. The castor oil plant (*Ricinus communis*), the food of *Attacus ricini* or Eri silkworm, is also very common here. As such, there is a large source of food-supply for silkworms for which rearing operations can probably be advantageously begun.

On an average, 20 good Mulberry trees of 7 or 10 years old afford sufficient food for one ounce of seed. Under favourable conditions, these worms yield about one maund of green cocoons, *i.e.*, every hundred Mulberry trees can yield 5 maunds of cocoons. The price paid to rearers for cocoons is about Rs. 15 per maund. Approximately 5 maunds of green cocoons feed 80 reeling basins working for a full day and yield 30 lbs. of best raw silk. The rearing season begins in Jammu about the first week of March and ends about the first week of May, when temperature averaging from 70° to 80° remains in the shade. In 1907, 1,500 ounces of seed were distributed, but the results of rearing were poor, as 1,025 ounces of seed produced 485 maunds of cocoons as compared with an yield of 304½ maunds from 350 ounces of seed in the previous year. The rearing of Tussar silkworms is being taken up. Wild Tussar is commonly produced on the *Ber* trees. Experiments are also being made to rear Eri silkworms fed on castor oil plant—(EDITOR).

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FIELD, GARDEN AND ORCHARD CROPS OF THE BOMBAY PRESIDENCY—Mr. G. A. Gammie, as Economic Botanist, Bombay, drew up in 1907, after eight years' observation, some notes on Field, Garden and Orchard Crops of the Bomay Presidency, mainly for the use of students and others interested in Agricultural Botany. These are now published in Bulletin No. 30 (1908) by the Department of Agriculture, Bombay. The botanical diagnosis of orders, genera and species are, in all cases, restricted so as to elucidate only the plants actually described. Mr. Gammie hopes to bring out shortly an illustrated edition of these notes with additions and corrections—(EDITOR).

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AMERICAN COTTON CULTIVATION IN INDIA.—The second auction of American cotton in the Jhelum Colony took place at Sargodha in January last, over 1,100 maunds being brought in. A gratifying feature of the sale was the appearance of representatives of the Delhi and Cawnpore mills, as it is probable that these mills can turn the quality of cotton to the best account. The

ultimate purchasers were the Muir Mills of Cawnpore, at Rs 7-7-0 per maund. This compares favourably with rates ranging from Rs. 5-8-0 to Rs. 6 for Deshi cotton on the same day, and with Rs. 7-5-3 realised at the first auction.

The auction system has placed the experiment on a much sounder footing than before; the produce is more widely known, and a better idea has been obtained of its market value. The growers have been brought into touch with the trade and have grasped the importance of marketing their crop free from admixture.

It would be premature to think that the cultivation of American cotton has been established; it must not be forgotten that the outturn per acre in 1907 was much less than with Deshi cotton and that the growers were out of the pocket. But they did well on previous occasions, and have done extremely well in 1908. The past season has suited American cotton as it has yielded much more heavily than Deshi, besides fetching a higher price.

The year's results may be regarded as encouraging, and it is certain that there will be an appreciable extension of cultivation in the Spring—(EXTRACT FROM THE "*Times of India*").

* * *

JUTE IN ASSAM—The *Indian Agriculturist* for November 1908 contains an interesting article and also an editorial on the prospects of jute cultivation in Assam as an outlet for European enterprise. Two plantations, Baroma and Patimari, were opened out in Kamrup District during the year 1906-7, both on newly-cleared jungle land on the north bank of the Brahmaputra. At present, there is no railway communication, and the nearest town is Gauhati which is across the Brahmaputra, forty miles from Baroma and nearly twenty miles from Patimari. Both plantations are, however, within fairly easy reach of the Dhubri-Gauhati extension of the Eastern Bengal State Railway, which is now nearly ready for traffic.

Away from the river and nearer the foot hills of the Himalayas, there is a good deal of land in Northern Assam not at

present under cultivation, which is covered by more or less dense reed jungle. This jungle by preventing the flow of water deposited by the heavy rains keeps land in a swampy condition which, when cleared, has an ample gradient for sufficient drainage. Bearing this in mind and remembering also that such soil contains the more or less imperfectly decomposed remains of many generations of plant growth, it is not surprising that it has been found necessary to open up the land sometime before sowing jute in order to allow it to become sufficiently aerated and weathered. So far, experience indicates that the best plan is to clear the jungle and break up the land with the "Kadauli" or a deep plough in the early cold weather. Ploughing is continued at intervals until April, after which the land is allowed to lie fallow until September. Cultivation then recommences for a cold weather mustard crop, which is best sown in September, though it may be put down as late as the middle of November. In this way the land is rendered comparatively free from weeds, and after the mustard has been taken off, three or four ploughings and one or two ladderings are sufficient preparation for the sowing of jute. It remains to be seen whether, instead of leaving the land fallow for 6 months, it would not pay to put it under Sann-hemp which, besides enriching the soil with Nitrogen, is itself a very effective clearing crop because its thick growth stifles weeds.

That the land in this part of Assam is naturally rich is proved by the very large crops of jute which have been produced on it. Moreover, owing probably to the comparative purity of the retting water, the fibre is of very fine quality so that it commands a high price in the market. The rainfall of the district is heavy and well distributed and the temperature high enough to produce the rapid growth necessary in jute. Local labour is fairly plentiful in Kamrup, but the population of this district is probably denser than that of any other part of the Assam Valley. In most districts, it would be necessary to import labour if the putting of a large area under jute were contemplated.

The article states that the retting and steeping of the

jute cost more than the actual cultivation. This is probably true if untrained labour is used ; it is within the experience of the writer of this note that untrained coolies have only been able, at first, to strip about 3 to 4 seers of dry jute a day, while a really good man can turn out upwards of a maund. Assuming an average wage of annas 6 per day, it is plain that the cost of the stripping process may be anything between annas 6 and Rs. 3-12-0 per maund.

Two years ago with the price for jute of average quality at Rs. 10 and over per maund, it paid to grow the crop, even at an extravagant cost of production : but the present price of Rs. 5 to Rs. 6 per maund renders it essential that expenses should be reduced as much as possible, and the inducement to Europeans to take up its cultivation is consequently not so great as it was. It would certainly be inadvisable, now, to put a large area under jute and attempt to work it off with untrained labour ; but it would be different if it were proposed to put down only a small area at first with the object of increasing the acreage later as the experience of both Manager and coolies justified the expansion. In fact, with normal prices, the same rule applies to jute as to tea or to indigo : no one would think of taking up the planting of either of the latter crops on a large scale without knowledge, based on experience, not only of the special manufacturing process, but also of the agricultural operations involved. Under these conditions, jute is still capable of yielding a reasonable profit to the European planter.

Attention is drawn in the article to the practice which obtains among buyers of systematically deducting a certain percentage from the weight of every consignment of jute on account of excessive moisture. There is no doubt, of course, that a large quantity of imperfectly dried jute comes into the market, and buyers are bound to protect themselves ; but if some discrimination in the way of better prices could be made between genuine and watered consignments, it could hardly fail, in the end, by encouraging honest dealing, to be advantageous both to the producer and to the buyer of jute—(R. S. Finlow).

REVIEWS.

PROCEEDINGS OF THE 15TH SERICULTURE CONFERENCE HELD AT SRINAGAR ON THE 23RD OCTOBER 1908, IN THE PRESENCE OF THE RESIDENT IN KASHMIR.

THE Proceedings show that in Kashmir during 1907-8, about 20 maunds of picked cocoons were received for breeding, and each moth was microscopically examined for disease. About 28,000 ounces of seed were distributed to 8 Tahsils. The number of rearers was 18,949 during 1907-8, being an increase of 1,900 over the previous year. The crop of cocoons was 23,490 maunds, 17 seers from 27,954½ ounces of seed, *i.e.*, an ounce of seed yielded 33 seers, 9 chhataks of cocoons. The new filatures are being fitted with electricity from the Jhelum, both for heating the water and turning the reels. The State Electric Department has made prolonged experiments in regard to the electric killing of cocoons, which show that by using tin-lined cases of 90 cubic feet capacity and by taking 6-7 h.-p. to kill 10 maunds of cocoons, each lot would take 2 hours 40 minutes to kill effectively. The Chief Engineer, Electric Department, remarks that electrocution would take less than one-third of the time required for *sechoir* killing, and that 13 boxes, as described above, could deal with 1,000 maunds in 24 hours. The experiments so far made, tend to show that the electrically killed cocoons give an enhanced production of silk. Further experiments as to this are being made. Taking the cost of electricity at £8 (Rs. 120) per h.-p., the cost of killing one maund of cocoons would be 10 annas 6 pies, considerably less than the cost of *sechoir* killing. Besides, the whole of the plant could be made locally at small cost. But about this, nothing has been finally decided.

In 1908, 240 bales of silk were sold at an average price of 12*s.* 11*d.* per lb., and the balance sheet for the year shows a net profit of Rs. 6,15,007.

The Silk Weaving Department of Kashmir is still working at a loss, and it cannot be made lucrative unless the factory is provided with expert weavers. The experimental filature for Jammu Sericulture is reported to be working satisfactorily, and the labour supply is increasing. A few seers of silk were sold at about Rs. 11-10-8 per lb. About 45 Mulberry nurseries have been made in 10 Tahsils, and arrangements are being made for storing cocoons—(EDITOR).

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ANNUAL REPORT ON THE WORKING OF CO-OPERATIVE CREDIT SOCIETIES IN THE BOMBAY PRESIDENCY (INCLUDING SIND) FOR THE YEAR 1ST JULY TO THE 30TH JUNE 1908.

THE steady progress of the Co-operative Credit Banks among the agricultural population of the Bombay Presidency shows that the principle of Co-operative Credit has begun to be understood. In the year under notice there were 145 Societies as compared with 69 during the year before. Of them, 99 are Rural, consisting mainly of agriculturists, and 46 Urban.

In Bombay there is no Central Society. The "Bombay Urban" and the "Broach District Society" are centres for lending to Rural Societies. In the year under review, loans were given by them at $9\frac{3}{8}$% interest.

The number of members of Urban Societies rose from 1,930 at the beginning of the year to 3,327 at its end. Those of Rural Societies rose from 5,405 to 8,477. The working capital of Urban Societies was Rs. 1,93,040, whilst that of Rural Societies was Rs. 3,69,880.

Government asked for information on the prevailing rates at which agriculturists borrow from money-lenders. The differences in the rates of interest vary greatly, but cannot be accurately ascertained. The average rate in the Presidency is probably about 18 per cent. per annum.

Repayment of loans during the year was creditable notwithstanding the "ignorance of summary procedure for recovery." Certain facilities to recipients of loans have been granted, which should help the formation of new societies—(EDITOR).

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BEHAR PLANTERS' ASSOCIATION, LTD. ANNUAL REPORT OF THE DIRECTORS TO THE MEMBERS OF THE ASSOCIATION FOR 1907-08.

THE Association continued to receive the grant of Rs. 50,000 from the Bengal Government for Indigo Research work at Sirseah. A Sub-Committee is chiefly responsible for the work. Eight publications on Indigo were issued by the Sirseah Committee and circulated.

In view of the expiration of the grant on the 31st March 1909, the Directors of the Association have submitted a scheme to the Bengal Government for further aid.

The Bengal Government made a grant of Rs. 7,500 to the Association for the services of a flax expert and purchase of seed. During the year, Mr. Emil Vanderkerkhove, a practical Belgian farmer, was employed as flax expert. The Inspector-General of Agriculture in India and the Director of Agriculture, Bengal, visited Dooriah, and after a thorough enquiry regarding the usefulness of flax as a commercial crop in Behar, advised the Association to retain Mr. Vanderkerkhove's services for another five years for the further development of the flax industry in India. Accordingly an agreement has been entered into between Mr. Vanderkerkhove and the Association from the 1st April 1908 to the 31st March 1913. The total cost of his services will amount to Rs. 5,500 annually, and this sum will be paid conjointly by the Government of India and the Bengal Government. Three circulars on flax were issued.

The Report states that the loan given by the Bengal Government to the Manager of the Benipore Sugar Factory was repaid by the Association.

Circulars on artificial and natural indigo, sugar, jute, rice, cotton, poultry, manuring, cattle-breeding, oats, wheats,

country crops and lac, were also issued and distributed by the Association—(EDITOR).

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A CHEMICAL AND PHYSICAL STUDY OF THE LARGE AND SMALL FAT GLOBULES IN COW'S MILK BY R. H. SHAW AND C. H. ECKLES (BULLETIN NO. III OF THE BUREAU OF ANIMAL INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE).

A NUMBER of new questions in dairy management have been raised by the widely extended use of the cream separator, which has enabled a much larger amount of butter to be obtained from a definite weight of milk than was previously possible. Among these is one which is, we think, finally set at rest by the publication now under consideration. The fat globules of milk may be divided into two groups of different sizes. The larger of these rise to the surface easily, and form the bulk of the cream obtained when this is allowed to rise naturally. The smaller particles of fat do not separate under these conditions: they are only made available for butter-making when the milk is passed through a separator. The higher the speed of the separator the smaller will be the particles of fat which are actually removed. It has often been suggested that these latter portions of fat derived from the smaller globules are not of the same composition as those which rise first, that they are most wax-like, that they have a higher melting point, and that they, hence, form a stiffer butter. The present bulletin shows, we think, conclusively, that there is, so far as cows in America are concerned, nothing in the suggestion. The fat, from the same milk, however separated, has essentially the same composition, and the use of the separator has not introduced any alteration in the quality of butter on this account. Any change or deterioration in the value of butter on the introduction of separators is due to some other cause than the composition of the fat globules which the milk originally contains.

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1ST AUGUST 1908 TO 31ST JANUARY 1909.

	Title.	Author.	Where published.
	General Agriculture.		
1	*Agricultural Journal of India*, Vol. III, Part IV. Price Rs. 2. Annual subscription Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta
2	*Agricultural Journal of India*, Vol. IV, Part I. Price Rs. 2. Annual subscription Rs. 6.	Ditto.	Ditto.
3	Seed Time and Harvest Time of Crops grown in Bengal. (Not for sale).	Department of Agriculture, Bengal.	Department of Agriculture, Bengal.
4	Flax in Behar. Departmental Records No. 1 of 1908. (Not for sale).	Ditto.	Ditto.
5	Annual Report of the Bengal Agricultural Department for the year ending 30th June 1908. Price annas 8.	Ditto.	Bengal Secretariat Book Depôt, Calcutta.
6	Annual Report of the Cuttack Agricultural Station for the year 1907-08. Price annas 4.	Ditto.	Ditto.
7	Annual Report of the Dumraon Agricultural Station for the year 1907-08. Price annas 4.	Ditto.	Ditto.
8	Annual Report of the Burdwan Agricultural Station for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
9	Annual Report of the Tasar Silk Rearing Station, Chaibassa, Bengal, for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
10	*Quarterly Journal* of the Agricultural Department of Bengal, Vol. II, No. 1. Price annas 8 per copy with postage.	Ditto.	Ditto.
11	*Quarterly Journal* of the Agricultural Department of Bengal, Vol. II, No. 2. Price annas 8 per copy with postage.	Ditto.	Ditto.
12	Implements, Manure and Seeds. Departmental Record No. 2 of 1908. (Not for sale).	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
13	Simple Notes on Common Cattle Diseases of Bengal. Leaflet No. 6 of 1908.	D. Quinlan, M.R.C.V.S., Superintendent, Civil Veterinary Department, Bengal.	Ditto.
14	Agricultural Statistics of Bengal for 1907-08. Price annas 8.	Department of Agriculture, Bengal.	Ditto.
15	Area and Yield of certain Principal Crops in India for the various periods from 1893-94 to 1907-08. Price 5 annas.	Commercial Intelligence Department, India.	Government Printing, India, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS - *contd.*

No.	Title.	Author.	Where published.
	General Agriculture – contd.		
16	Report of the Indigo Research Station, Sirseah, for the year 1908-09.	Cyril Bergtheil, Imperial Bacteriologist.	Behar Planters' Association, Mozufferpore.
17	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1908. Price 8 annas.	Department of Land Records and Agriculture, United Provinces.	Government Press, United Provinces Allahabad.
18	Annual Report on the Cawnpore Agricultural Station for the year ending 30th June 1908. Price Re. 1.	Ditto.	Ditto.
19	Annual Report on the Jalaun (Orai) Agricultural Station for the year ending 30th June 1908. Price 8 annas.	Ditto.	Ditto.
20	Note on the Demonstration and Experimental factories worked during the Sugar Season, 1907-08.	Khan Bahadur Saiyid Mohamad Hadi, M.R.A.C., M.R.A.S., Assistant Director, Land Records and Agricultural Department, United Provinces.	London Printing Press, Lucknow.
21	American Cotton and the Method of its Sowing (in Urdu and Hindi). Leaflet.	Department of Land Records and Agriculture, United Provinces.	Newal Kishore Press, Lucknow.
22	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1908. Price 3 annas.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press, Lahore.
23	Annual Report of the Lyallpur Agricultural Station for 1907-08. Price 5 annas.	Ditto.	Ditto.
24	Annual Report of the Department of Agriculture of the Bombay Presidency for the year 1907-08. Price 5 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
25	Annual Report on the Experimental Work of the Surat Agricultural Station for the year 1907-08. Price 14 annas.	Ditto.	Ditto.
26	Annual Report on the Experimental Work of the Dharwar Agricultural Station for the year 1907-08. Price 12 annas.	Ditto.	Ditto.
27	Annual Report on the Ganeskhund Botanical Station. Price 5 annas.	Ditto.	Ditto.
28	Annual Report on the Bassein Botanical and Agricultural Station. Price 4 annas.	Ditto.	Ditto.
29	Annual Report on the Experimental work of the Dhulia Agricultural Station for the year 1907-08. Price 5 annas.	Ditto.	Ditto.
30	Season and Crop Report of the Bombay Presidency for 1907-08. Price 7 annas.	Ditto.	Ditto.
31	Field, Orchard and Garden Crops of the Bombay Presidency: Bulletin No. 30 of 1908. Price 12 annas.	G. A. Gammie, F.L.S., Economic Botanist to the Government of Bombay.	Ditto.
32	Establishment and Management of the Dairy Farm: Bulletin No. 31 of 1908. Price 3 annas.	G. K. Kelkar, Assistant Professor of Agriculture, Poona.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
33	Annual Report of the Experimental Work of the Nadiad Agricultural Station for the year 1907-08. Price 6 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
34	Annual Report on the Experimental Work of the Muvalia Agricultural Station for the year 1907-08.	Ditto.	Ditto.
35	Annual Report on the Experimental Work of the Mirpurkhas Agricultural Station for the year 1907-08. Price 8 annas.	Ditto.	Ditto.
36	Annual Report on the Experimental Work of the Daulatpur Reclamation Station for the year 1907-08. Price 3 annas.	Ditto.	Ditto.
37	Annual Report on the Experimental Work of the Manjri and Lonavala Agricultural Stations for the year 1907-08. Price 5 annas.	Ditto.	Ditto.
38	Annual Report on the Experimental Work of the Kirkee Civil Dairy Farm for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
39	Annual Report on the Experimental Work of the Agricultural College Station, Poona, for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
40	Report of the Operations of the Department of Agriculture, 1907-08. Price 6 annas.	Department of Agriculture, Madras.	Government Press, Madras.
41	Scientific Report of the Hagari Agricultural Station for the year 1907-08. Price 2 annas.	Ditto.	Ditto.
42	Scientific Report of the Bellary Agricultural Station for the year 1907-08. Price 2 annas 3 pies.	Ditto.	Ditto.
43	Scientific Report of the Palur Agricultural Station for the year 1907-08. Price 8 annas.	Ditto.	Ditto.
44	Scientific Report of the Samalkota Agricultural Station for the year 1907-08. Price 3 annas.	Ditto	Ditto.
45	Scientific Report of the Nandyal Agricultural Station for the year 1907-08. Price 1 anna 6 pies.	Ditto.	Ditto.
46	Scientific Report of the Talipparamba Agricultural Station for the year 1907-08. Price 6 annas.	Ditto.	Ditto.
47	Scientific Report of the Koilpatti Agricultural Station for the year 1907-08.	Ditto.	Ditto.
48	"Sann-hemp" (*Crotalaria juncea*): Bulletin No. 59. Price 1 anna.	Rao Bahadur C. K. Subba Rao, B.A.	Ditto.
49	Agricultural Calendar for 1909. (In English, Tamil and Telugu). Price 1 anna.	Department of Agriculture, Madras.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
50	Report on the Working of the Department of Agriculture, C. P., for the year 1907-08. Price Re. 1.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
51	Report on the Agricultural Stations in the Central Provinces for the year 1907-08. Price Re. 1.	Ditto.	Ditto.
52	Report on the Management of the Provincial and District Gardens in the Central Provinces for the year 1907-08. Price Re. 1.	Ditto.	Ditto.
53	How to Apply Nitrate of Soda as a Manure for Cotton.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	*Deshsewak* Press, Nagpur.
54	Varieties of Potatoes grown in the Central Provinces: Bulletin. Price Re. 1.	G. Evans, B.A. (Cantab.), Deputy Director of Agriculture, Northern Circle, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
55	*Agricultural Gazette*—a monthly publication. Price 2 annas per copy.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	*Deshsewak* Press, Nagpur.
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